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AN ECONOMIC ANALYSIS
OF
MILITARY EXPENDITURES

by

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An Economic Analysis
of
Military Expenditures

by

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ABSTRACT

This thesis empirically explores the nature of the relationships between members of formal and informal alliances. A pooled time series cross sectional data methodology is employed to analyze those factors believed to have a significant impact on the behavior of national governments in allotting funds for defense. Regression analysis is performed on seventy-five countries over an eleven year period (1974-1984) including both NATO and non-NATO members; communist and non-communist nations; and developed and less-developed countries. The empirical results reveal inconclusive evidence for the traditional view that an inverse relationship exists between the military expenditures of allies. The distinction between formal and informal allies provides no further evidence of support and exposes some of the weaknesses of this view of military alliances.

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I. INTRODUCTION

A. OBJECTIVE

The purpose of this research is to test the explanatory power of factors that are likely to have a significant influence on the defense spending of our allies and rivals. The factors that will be tested for their degree of impact on military expenditures include: gross national product (GNP), military expenditures of formal and informal allies, military expenditures of rival countries, social expenditures, and constraints on military expenditures imposed by treaty or constitution. These factors were selected as potentially important determinants of defense spending after a thorough examination of both the theoretical literature and prior empirical research.

This thesis topic is designed as an extension of a project completed by Dr. Stephen L. Mehay and Dr. Rodolfo A. Gonzalez, "An Economic Model of the Supply of Military Output," April 1987, Naval Postgraduate School, Monterey, CA. Their project utilized the theory of bureaucracy to analyze the collective choice mechanism for determining a country's military spending. Spillover effects on a nation's military spending from its allies and rivals were investigated for one year of data (1982).

This study conducts an analysis similar to their research, but differs in two ways. First, the sample consists of data over an eleven year period, 1974 -1985. Second, and even more important, this study directly tests the extent of free riding behavior occurring among formal allies and allies who are not members of formal alliances.

The primary purpose for testing for relationships between a nation's military expenditures and the defense spending of her allies and rivals is to develop a regression model that accurately predicts the behavior of national governments in allotting funds for defense. Additionally, this research provides an understanding of some of the factors that have the greatest impact on the military expenditure of a nation.

The data base for this study was developed from selected data contained in the *World Military Expenditure and Arms Transfer* manual developed by The U.S. Arms Control and Disarmament Agency, Washington, D.C., 1986.

B. BACKGROUND

This thesis capitalizes on many of the same measures and methodologies employed in the work of Dr. Mehay and Dr. Gonzalez. Both studies utilize regression analysis techniques for testing the individual data bases to develop optimal models.

Dr. Mehay and Dr. Gonzalez used income, population, social spending, political structure, volunteer force, and spending limitations to test for a nation's military spending. Their model integrated economies of size in military output from both the consumption (publicness) and production (scale) sides. This study is similar and builds on their concepts by introducing more variables believed to have a significant impact on a country's defense spending. Specifically, a distinction is made between a formal ally and an informal ally. The end result is an improved model.

Their research discovered that while economies of size to national defense appear to be important for western nations, they appear to be lacking in less developed countries. This difference was thought to be due in part to the different weapons mix

between the two samples. The weapons mix among the western nations is weighted toward deterrent weapons, but in comparison the less developed nations tend to favor conventional forces and protective weapons.

The study completed by Dr. Mehay and Dr. Gonzalez resulted in a specific regression model to explore an alternative decision making model that takes into account autonomous preferences by government decision makers. Because only one year of data was used and no distinction was made between formal and informal allies, this may have negatively impacted the performance of their model.

C. PUBLIC GOOD

As in prior studies of defense expenditures, it is assumed that defense services exhibit to a significant degree the characteristics of a public good. Public goods are goods which are jointly consumed by individuals.

The notion of a pure public good is germane to this study and must be formally defined. Todd Sandler, in his article entitled "Sharing Burdens in NATO," offers the following definition:

> A good is a pure public good when its benefits are nonrival and non- excludable. The benefits of a good are nonrival whenever a unit of the good can be consumed by one agent without detracting, in the slightest, from the consumption opportunities still available to others from the same unit. Benefits that are available to all agents once the good is provided are termed nonexcludable. [Ref. 1:p. 30]

Examples of public goods include firework displays, national defense, pollution-control devices and street lighting. More than one person can simultaneously benefit from the above goods without diminishing the value of the good to others, and it is

virtually impossible to exclude any individual from consuming the good once it is provided.

D. THE SUBSTITUTION EFFECT

When the price of a good rises, ceteris paribus, the consumer is usually affected in two principal ways. First, the consumer's real income or purchasing power is reduced, because the higher price reduces the amount of commodities that can be purchased. In addition, the price increase makes the good a relatively poorer bargain compared to its substitutes, so the consumer substitutes other goods that are cheaper in place of the now more expensive one. This second response is called the substitution effect. [Ref. 2:p. 75]

Mancur Olson Jr. and Richard Zeckhauser (1966) assume that the output of an ally is a substitute good. They were among the first to argue that the pure public good nature of national defense and differences in member size led to larger members bearing a disproportionate share of the burden of the common defense of an alliance. In other words, it was predicted that the smaller allies would free ride by relying on the contributions of the larger allies for protection. The term free rider in this context means that a country contributes less than her derived benefits would warrant.

E. THESIS ORGANIZATION

Chapter II reviews the various theories developed to help explain the defense expenditure of a nation. This chapter describes the theory and assumptions presented by Mancur Olson Jr. and Richard Zeckhauser. The non-cooperative model of Olson and Zeckhauser has provided the theoretical basis for many subsequent studies and

alternative views. Some of those alternative views, such as those argued by Todd Sandler and his colleagues, are presented.

Chapter III discusses the model used to test the theoretical hypothesis. All variables are fully explained and the problems, methodology, assumptions and procedures for testing the data base are discussed. The model is very similar to the one used by Dr. Mehay and Dr. Gonzalez in their study.

Chapter IV describes the sample selection and data collection procedures employed in developing the data base. A list of the countries included in the analysis and the rationale for their selection to certain sample groups is discussed. The table of allies and rivals is constructed for all seventy-five countries included in this study.

Chapter V details the data analysis procedures used to test specific hypotheses. The statistical tests address the central research question: Is there an inverse relationship between a nation's military expenditure and that of its allies. Regression models were constructed to separately address the central research question in the context of various subsets of the data base.

Chapter VI presents a summary of the results, the final conclusions and recommendations.

II. THEORETICAL REVIEW OF MILITARY EXPENDITURES

A. FRAMEWORK

Economic analyses of a nation's military output have been organized around two distinct but related lines of reasoning. The first approach, argued by Mancur Olson Jr. and Richard Zeckhauser in 1966, focuses on the pure public good attribute of national defense and discusses the free-riding behavior of smaller nations on large, defense-producing nations. They suggest that the bureaucracy of formalized (military) alliances creates recurring situations which make smaller nations unwilling to contribute to the common defense in proportion to the share of benefits they receive. As a result, the smaller nations force the larger ones to take on more of the organization's military requirements. These larger, industrialized nations therefore bear a disproportionate share of the burden.

The second line of reasoning has been based primarily on the studies of Todd Sandler and his colleagues. Their approach argues that NATO defense activities produce different types of weapons depending on the degree of publicness. In other words, military alliances produce a mix of outputs, some of which are not purely public. Their reasoning suggests that some defense expenditures will induce complementary behavior among alliance nations rather than the substitution effects envisioned by the Olson and Zeckhauser model.

1. General Qualifications

An important point often neglected in the burden sharing debate is that efficiency requires a balance of contributions and benefits. In other words, there should be a balance between the percent of a nation's contribution and the percent of benefit received.

Ideally, what we would like to measure is total contribution relative to total benefit. However, since it is difficult to accurately measure benefits, it is assumed that GNP or GNP per capita can be used as a proxy (e.g., benefit from security is measured by the wealth one stands to lose). Additionally, one assumes that total contribution can be measured by defense expenditures. Using expenditures and GNP only indicates whether there is free riding if both of these assumptions are true. If there are other benefits (i.e., American drive for superiority, force projection, economic spillovers, etc.) or other types of contributions (i.e., land, facilities, inconvenience to population, etc.) then these measurements do not adequately measure the presence of free riding. Both of these assumptions are adopted by convention for this analysis.

Another implicit assumption throughout the discussion on military expenditures is that there should be proportional sharing of the defense burden in an alliance. In other words, expenditures should be proportional rather than based on sacrifice. However, this is contrary to the U.S. income tax scheme which says that sacrifice should be proportional. If this were true, one would expect wealthier nations to contribute more (assuming diminishing marginal utility of income or wealth). As well, many less wealthy countries might be bearing more than their share of sacrifice.

B. THE FIRST LINE OF INQUIRY

In the mid-1960's, Olson and Zeckhauser postulated a clever hypothesis to explain the disproportionate burden sharing observed among countries in the NATO alliance. The NATO group was chosen because of its large amount of resources and because it provided adequate data to test the implications of their model. They argued that U.S. strategic nuclear weapons provided mostly public benefits that were nonrival to the allies and also nonexcludable. That is, the nuclear deterrence provided by the U.S. arsenal could underwrite the security of the other allies without diminishing the deterrence provided to the United States itself.

When allies contribute toward an arsenal whose benefits are shared by all without regard to payment, smaller allies have an incentive to ride free by relying on the contributions of the larger allies for protection. Such selfish behavior allows the free rider to spend its scarce resources on other things. Thus, the shared defense benefits provided by a nation's allies are equivalent to an increase in the nation's income.

In great depth, the Olson and Zeckhauser argument purports to explain how, from an economic vantage point, alliances operate. Its primary focus is on the NATO countries, although the model utilized can be applied to other alliances. Measured as either a percentage of their GNP or a percentage of their government budgets, smaller nations expend significantly less of their budgets toward defense than do larger member nations. If GNP is used as a proxy for the benefits of national security, the larger countries contribute more than their proportionate share to the alliance while the smaller nations contribute less in comparison to the benefits they derive. According to Olson and Zeckhauser, their research proved that there was a significant "positive

correlation" between the size of a member's national income and the percentage of its national income devoted to the common defense [Ref. 3:p. 277].

In a similar manner, it has been noted that the alliance does not adequately fulfill its own established quota of military division requirements. The facts usually indicate that it is the smaller nations that do not supply the necessary resources to meet their quota requirements. The United States' contribution has increased beyond its quota to balance the deficiency of other alliance members. Of course, this simply causes some participants to benefit from their alliance membership without paying their dues. As a result, the independence of the group is threatened due to the disproportionate expenditure of resources by the larger nations in contrast to the smaller nations' contributions.

There are various reasons to help explain this occurrence. Perhaps there exists an American drive for superiority and dominance based on moral supremacy. Another reason is obviously linked to how member nations manage and allot their resources to meet such requirements. Clearly, the answer to NATO's disproportionality problem and why it is not fully equipped to satisfy its own preestablished charter lies in the bosom of how much (and why) these member nations give to the whole organization.

Throughout the discussion and analysis presented by Olson and Zeckhauser, it is assumed that there will always be some degree of disproportionality involved. However, there is one important case where they believe there will be no tendency toward disproportionality. This would occur if defense became a superior good. A superior good is one where expenditures on the good increases by as much or more than income increases. Applying this definition to military spending, all of the increase

in income that a nation receives in the form of defense provided by allies is spent on defense goods. In other words, as a nation gets more free defense from an ally, it would not reduce its own military expenditure.

This special case could be an important one. Olson and Zeckhauser offer the following: "During periods of all-out war or exceptional insecurity, it is likely that defense is (or is nearly) a superior good, and in such circumstances alliances will not have any tendency toward disproportionate burden sharing." [Ref. 3:p. 271]

Olson and Zeckhauser further argue that the defense output of allies yields a collective security (public) good which is shared equally by all alliance members, but whose production level depends on the separate expenditure decisions of each ally. Each nation is assumed to choose its defense output without considering the spillover effects its decisions have on the other members.

One rational explanation for this behavior stems from the concept of suboptimality. As they (Olson and Zeckhauser) view alliance interactions, there will always be a suboptimal amount of defense produced. In other words, even though a specific amount of defense can be obtained from the collective contributions of alliance nations, the collective effort will fall short of the optimal amount. It must be emphasized that efficiency requires a balance of contributions and benefits. It is best said by Olson and Zeckhauser [Ref. 3:p. 271]:

> Although there is then one exception to the rule that alliance burdens are shared disproportionately, there is no equivalent exception to the rule that alliances provide suboptimal amounts of the collective good. The alliance output will always be suboptimal so long as the members of the alliance place a positive value on additional units of defense. This is because each of the alliance members contributes to the point where its marginal rate of substitution for the good equals the marginal cost of the good...There could be an optimal quantity of the collective good only if the total value which all of the alliance members

> together placed on an additional unit of the good equalled marginal cost,...The individual nations in an alliance would have an incentive to keep providing additional alliance forces until the Pareto-optimal level is reached only if there were an arrangement such that the alliance members shared marginal costs in the same proportions in which they shared additional benefits (that is, in the same ratio as their marginal rates of substitution of money for the good). When there is such a marginal cost sharing scheme, there need be no tendency toward disproportionality in the sharing of burdens.

According to Olson and Zeckhauser, one possible solution to the problem of disproportionality and suboptimality is institutional changes that alter the pattern of incentives. Suboptimal decision-making is a common characteristic of large organizations. The vehicle, therefore, to change this outcome would be to change policies. From this manipulation, it is possible that less of a disproportionate share of the burden would be carried by the large, defense producing nations. Also according to Olson and Zeckhauser, these policy changes "...at least have the merit that they help to make the national interests of individual nations more nearly compatible with the efficient attainment of the goals which groups of nations hold in common." [Ref. 3:p. 279]

Another plausible solution to the problem is to harness the "differences of purpose" that already exist in an alliance or international organization. The model implies that alliances and international organizations will not work efficiently regardless of how complete the agreement and "community of interest" among the members. Some differences of purpose increase the private, non-collective benefits and in doing so they improve the working of the alliance. For example, many European NATO members probably would have smaller military forces and contribute less to NATO if it were not for their private interests and fears. In viewing the long-term effect, these

differences will alleviate the suboptimality and disproportionality problems and improve the alliance. [Ref. 3:p. 279]

In another respect, part of the solution is in the analysis of why and how such organizations exist. Olson and Zeckhauser [Ref. 3:p. 267] state that one purpose that all such organizations must have is that of serving the common interests of member states. In the case of NATO, the proclaimed purpose of the alliance is to protect the member nations from aggression by a common enemy. The combined defense effort of these countries contributes to the common defense of the group. Hence, we have a collective consumption situation. Olson and Zeckhauser describe its characteristics:

> Such a common objective is a collective good, since it has one or both of the following properties: (1) if the common goal is achieved, everyone who shares this goal automatically benefits, or in other words, nonpurchasers cannot feasibly be kept from consuming the good, and (2) if the good is available to any one person in a group it is or can be made available to the other members of the group at little or no marginal cost. [Ref. 3:p. 267]

Critical to the first line of reasoning is the idea that an individual member acting apart from the group usually has no incentive to provide optimal amounts of such goods. Where the group interested in a public good is very large, and the share of the total benefit that goes to any single individual is very small, usually no individual has an incentive voluntarily to purchase any of the good [Ref. 3:p. 267]. In the case where the group is small, members will usually have an incentive to provide for the collective good, and to make appropriate sacrifices to do so, but usually they will tend to provide only suboptimal amounts of this good. "There will also be a tendency for the larger members - those that place a higher absolute value on the public good - to bear a disproportionate share of the burden...." [Ref. 3:p. 268]

Simply stated, the first line of reasoning explores the commodity or "good" of military security considering its public good characteristics. The economists, Rodolfo Gonzalez and Stephen Mehay, in their article, "An Economic Model of the Supply of Military Output," describe it this way: "Olson and Zeckhauser (1966) argued that in alliances the pure public good attribute of national defense and differences in member size combine to create free riding behavior by smaller members." [Ref. 4:p. 2] In essence, in an alliance the output of allies is a substitute for the amount a nation spends on its own defense.

1. Assumptions

The Olson and Zeckhauser model revolves around the premise that countries place a specific value on national defense at the expense of other goods (nondefense) that could have been purchased. Naturally, in an alliance, the amount a nation spends on defense will be affected to some extent by the amount its allies provide. Their non-cooperative model of military alliances has several important assumptions that are critical in justifying their conclusions.

The first assumption is that defense is in fact a pure public good. As such, its enjoyment is shared by all in the alliance and it is not feasible (and sometimes not even possible) to exclude any member from consuming it. The "free rider" problem is based on this assumption.

Another assumption in the model is that all goods are "normal goods." Normal goods are goods such that if a consumer's income increases, the number of units purchased of the good also increases. However, even Olson and Zeckhauser [Ref.

3:p. 279] admit that if defense became a "superior good" such as in "all-out war or extreme insecurity," there would be no tendency toward disproportionality.

Throughout their reasoning, it is assumed that the "costs of defense are constant to scale and the same for all alliance members." [Ref. 3:p. 271] However, it is more accurate to consider that some types of weapon systems and ground forces do have rising costs. Alternatively, other weapon systems have "undoubtedly striking economies of large scale production...." [Ref. 3:p. 271] As a result, there will be differences between the defense expenditures of large and small nations on these items. Olson and Zeckhauser conclude that regardless of the differences in marginal costs among countries, the basic premises of their argument are not altered.

Although not specifically cited in the literature, an implicit assumption in their model as noted by the economists Gonzalez and Mehay [Ref. 5:p. 1] is that the output of one nation does not enhance the marginal effectiveness of the alliance output. In other words, the model completely rules out the possibility of complementarity among members' defense outputs.

Another assumption in their model is that the military forces in an alliance provide only the collective benefit of alliance security, when in fact they also provide national, non-collective benefits to the nations that maintain them [Ref. 3:p. 272]. For example, when the Soviet Union mobilized additional forces to suppress the independence movement in Angola, a national goal unrelated to the purposes of the WARSAW PACT, she simultaneously increased the total strength of the WARSAW alliance. Olson and Zeckhauser [Ref. 3:p. 272] state that "in any situations in which the military forces of alliance members provide important non-collective benefits as

well as alliance benefits, the degree of suboptimality and the importance of the disproportionality will decrease because the non-collective benefits give the member nations an incentive to maintain larger forces."

A final qualifying assumption of the model is that alliance members do not take into account the reactions of other members in their defense contributions. One reason for this behavior, according to Olson and Zeckhauser [Ref. 3:p. 273], is that alliances are often involved in situations that contain a strong element of irreversibility. A second factor is the difference between market and non-market groups [Ref. 3:p. 273]. Market groups traditionally engage in price wars or cut-throat competition to drive competitors out of the industry. However, non-market groups, such as alliances, usually strive for large membership, since the supply of the collective good increases as the membership increases.

C. THE SECOND LINE OF INQUIRY

The second approach to military spending has revolved around the research of Todd Sandler and his colleagues. In contrast to the Olson and Zeckhauser non-cooperative model, Sandler developed the "joint product" model in 1977. This model emphasized a theory of military interdependence, allowing for the possibility of complementarity between the defense spending of the members of an alliance. Since the original joint product model, empirical analysis of these arguments has continued to focus on specifying demand functions for defense output.

Sandler (1980) argues that his joint product model is the most comprehensive model of alliance behavior because it includes private, impure public, and pure public outputs of defense expenditures [Ref. 6:p. 425]. Moreover, he feels that because of

changes since the Olson and Zeckhauser model (1966), the straightforward application of the pure public good model is no longer appropriate for defense alliance behavior. Sandler [Ref. 6:p. 426] states that "the change in NATO's military strategy, the development of new weapon systems, and the increase of disputes exogenous to the East-West split favor the application of the joint product model, since rivalry in consumption, multiple outputs, benefit exclusion, and private benefits are increasingly characterizing modern alliances."

Sandler and Murdoch surmise that complementarity among the joint products of the NATO members may be the result of the move away from what is called mutual assured destruction (MAD) towards the flexible response doctrine of the mid-1970's. In the latter case, NATO nations engage their security forces in multiple arenas to avoid a full-scale nuclear confrontation. It is believed that any conflict provoked by Warsaw Pact challenges will initially begin with the use of conventional and tactical weapons followed by military armament exchanges with nuclear weapons. Therefore, the perspective is of a progressive and sequential confrontation between national powers.

In this vein, no longer can NATO countries rely on nuclear weapons' deterrence to fend off security challenges. They must at a minimum be prepared to defend themselves against conventional aggression. Hence, the concept of a flexible response allows for the conventional and tactical response necessary in the early stages of a European conflict. Sandler and Murdoch offer the following:

> ...the nuclear and non-nuclear arsenals contribute to each other's value; they become complementary. This, therefore, implies a complementarity between the military activities of the smaller European allies and the larger nuclear nations. [Ref. 7:p. 90]

According to this view, if a member nation does not keep pace with the military activity of its allies, it could be inviting trouble. An opponent may take the opportunity to gain an advantage by creating a confrontation on that ally's territory. In this situation, of course, the conflict is considered to be conventional. Sandler and Murdoch write [Ref. 7:p. 90]:

> ...with strong complementarity, an ally's military activity could increase in response to greater alliance-wide military activities. In reality, the military activity of a nation is quite closely measured by its military expenditures...a NATO ally is predicted to have less desire to free ride.

The joint product approach allows for a relationship of complementarity between defense goods by introducing various defense commodities into the model. A distinction is made between strategic and conventional forces in developing this model of defense. Sandler and Forbes call attention to the fact that many nations have different mixes of weapons, each with its own degree of publicness. They describe a purely deterrent weapon as one with the sole purpose of conveying "a credible retaliatory threat on behalf of an alliance" (e.g., Trident submarines, B-1 bombers), while weapons are classified as purely protective or damage-limiting when they are deployed "to deny an enemy its military objective." [Ref. 6:p. 427] Another type of weapon is called a mixed defense weapon. This is a weapon that satisfies both deterrent and damage-limiting purposes such as multi-purpose aircraft and cruise missiles.

The model suggests that the inherently different types of weapons and the adoption of the doctrine of flexible response by NATO during the early 1970's caused a complementarity relationship among alliance members. As a result, it appears that the extent of free riding in the NATO alliance has diminished. Among NATO nations,

only a minority (Canada, Germany, Turkey, and the United Kingdom) are found to act in accordance with the free rider hypothesis advanced by Olson and Zeckhauser. [Ref. 8:p. 261]

1. Improving the Joint Product model

Todd Sandler and James C. Murdoch (1982) improve and refine the joint product model so that it can better analyze nuclear war alliances. In particular, they suggest that the refined models demonstrate that allies' responses to defense spillovers depend upon the consumption relationship (i.e., complementarity or substitutability) of the jointly produced defense outputs as well as the allies' income responsiveness [Ref. 8:p. 239].

Their research is centered around a theoretical model of a nuclear war alliance. From this model, it is believed that when the jointly produced defense outputs are complementary, allies may increase their defense expenditures in response to the spill-ins from large defense producing nations. Spill-ins are the benefits received from the defense expenditures made by another ally. Furthermore, it is suggested that the stability and size of alliances are also related to the consumption relationship of the jointly produced outputs." [Ref. 8:p. 237] Finally, they present the idea that the influence of spill-ins (or spillovers) on both arsenal maintenance and the membership size of the organization can be determined and traced to the "consumption relationship of the jointly produced outputs." [Ref. 8:p. 239]

In the joint product model, an alliance is depicted "as relying upon an arsenal that provides deterrence, damage-limiting protection (needed when deterrence fails), and private benefits." [Ref. 8:p. 242] This model suggests that wealth is not the

only variable that influences the patterns in defense expenditures. Damage-limiting weapons (e.g., tanks, anti-ballistic missiles) can be partially rival in a sense between allies. Such would be the case if they are positioned along a common border. Sandler [Ref. 6:p. 427] purports that "when an arsenal of damage-limiting weapons is required to protect a larger front or boundary as a new ally joins, a thinning of forces results from a spatial rivalry which detracts from the protection of the existing allies." These weapons can be deployed elsewhere or withheld from engagement. In other words, their services (or benefits) can be excluded. According to this line of reasoning, the end-result is that the alliance enjoys "pure public (deterrence), impure public (damage-limitation forces), and private benefits." [Ref. 3:p. 242]

Sandler's theoretical analyses suggest that the military expenditures of any ally are a function of four separate factors. These include wealth, thinning, spill-ins, and strategic strength.

The first factor, wealth, is a measure of an ally's gross domestic product. Thinning, the second factor, is approximated by the ratio of an ally's military personnel to its exposed border. This variable captures the potential density of the ally's armed forces along its exposed perimeter. The third factor, spill-ins, is determined from net NATO expenditures after subtracting the ally's own defense expenditures. The last variable is the relative strategic strength of NATO. It is expressed by the ratio of U.S. long-range missiles (ICBMs and SLBMs) plus long range bombers to USSR long-range missiles and bombers.

From the results, Sandler and Murdoch predict nations will not respond positively to spill-ins when free riding is possible or when the jointly made products

of defense are substitutes. However, if the outputs are complementary, the results indicate that an ally will actually increase defense spending in reaction to the spill-ins. They believe that the flexible response doctrine will cause a complementary relationship between deterrent and damage-limiting weapons. Furthermore, this complementary relationship should be particularly prevalent for those countries that have colonial interests.

In a similar manner, Sandler and Murdoch (1984) examine some of the major factors that influence a nation's demand for military spending. Their research cites two primary findings in alliance activity among its members. The first is the "free rider" concept whereby some in the alliance contribute a greater share of their gross domestic product to military expenditures and thus carry more of a security burden. This phenomena is consistent with the Olson and Zeckhauser model and matches their description of disproportionality. The second observation made is that there have been significant changes in the shares of military expenditure over time (1960-1979). Specifically, they note that the military share gap has closed between all of the relatively large and small nations and this closing is due to the dramatic reductions in the shares of the nuclear allies. Of course this suggests that the extent of the free rider problem in the NATO alliance has diminished.

D. SUMMARY

This chapter has offered the two main views on the economic analyses of a nation's military expenditure. Olson and Zeckhauser were the first to present a public goods approach to the study of alliance behavior. They depicted NATO as sharing a pure public good in the form of deterrence. Their study showed that responses to

spill-ins only depended upon income responsiveness and that, in most situations, spill-ins caused allies to cut defense expenditures. This approach focuses on the pure public good characteristic of national defense and emphasizes the substitution effect of military expenditures in an alliance.

In contrast to this first line of inquiry, Todd Sandler and his colleagues offer a second view suggesting that when the jointly produced outputs are complementary vice substitutable, allies could increase their defense expenditures in response to spill-ins. Thus, the joint product model emphasizes the complementary effect of defense expenditures and offers the possibility of cooperative behavior among alliance nations.

III. THE MODEL

A. INTRODUCTION

The model offered here attempts to portray inherently the decisions made by government executives in defense expenditures. The theory can be applied to any nation because clinically this framework targets those variables predicted to have a strong, positive impact on the outcome of military expenditures.

Analogous to the model used in the Gonzalez and Mehay research, this study assumes that there is an interaction or interdependence made among nations that are rival and among nations that are allies.

Similar to the Gonzalez and Mehay work, this model offers two primary advantages over previous economic research on national defense spending. First, the model incorporates the interdependence of military decisions between rivals as well as between allies. Secondly, prior research has concentrated on the spillover effects between allies who are members of formal alliances, generally NATO. This narrow focus omits consideration of nations that are operational allies even though they are not members of formal alliances, and includes nations who are formal but not operational allies. This research expands the scope of inquiry by investigating spillovers between nations that can be defined as operational or informal allies, regardless of whether they are members of formal alliances.

This study does not emphasize the type of good that is provided by a military alliance, but rather that the good has a significant degree of publicness and yields

benefit to all the members of the group. It is assumed that nations do not have to belong to a formal alliance for the theory to apply. Since it is assumed that deterrence is a public good, whether a country is formally participating in an alliance or not, they are the benefactors of their own defense production along with the production of other nations who they informally ally with. Olson and Zeckhauser write: "Another assumption in the model developed was that the military forces in an alliance provide only the collective benefit of alliance security, when in fact they also provide purely national, non-collective benefits to the nations that maintain them." [Ref. 3:p. 272]

It should be clear that it is also assumed that defense has an element of publicness (public good) both among members of a formal alliance and among nations informally allied. In addition, the view toward defense is comprehensive. Though the two basic research studies cited earlier discuss the issues of economies of size (consumption and production) of weaponry, this study views military spending as a whole. The issue is not the types of weapons that are produced, such as conventional versus nuclear or tactical versus strategic. Rather, the pertinent issue is when national officials make their fiscal decisions, which variables have the greatest influence on the resulting defense spending policy. The Olson and Zeckhauser model assumes that the costs of defense are constant to scale and the same for all alliance members. Although military forces are composed of different types of equipment and manpower, it is still unlikely that costs are constant and uniform. However, because the emphasis of this study is on testing for relationships between a country's military expenditure and that of its allies, the costs of defense are irrelevant and do not affect the model.

B. THEORETICAL BASIS

There are numerous theories that have been developed and used to explain national military expenditures. The basic premise of this research is that national defense spending is a function of a nation's population (POP), income per capita (PCI), government social expenditures (SE), military expenditures of formal allies (FA), military expenditures of informal allies (IA), and the military expenditures of rival countries (RIV). Written in a theoretical formula, the following is derived:

$ME_{it} = f(POP_{it}, PCI_{it}, SE_{t-1}, FA_{t-1}, IA_{t-1}, RIV_{t-1})$. That is to say that:

i = a particular nation
t = time/specific year
$t\text{-}1$ = time lagged by one year

According to Gonzalez and Mehay [Ref. 4:p. 11], the reaction effects between allies and rivals introduce potential simultaneity into the estimation of the above formula. In addition, the construction of the variables for ally and rival spending assumes that a reciprocal relationship exists between nations identified as allies and rivals; that is, the set of nations identified as allies (or rivals) of a nation i will also have i as an ally (or rival).

However, it is questionable whether simultaneity is a serious concern in defense spending patterns across nations. It is likely any reaction effect will occur with a considerable lag since information on an ally and, especially, rival spending may not be known with certainty during a nation's budgetary cycle. This reasoning suggests that the proper specification of the above formula should incorporate lags in the ally and rival variables.

Following Murdoch and Sandler (1984), and Gonzalez and Mehay (1987), time is lagged by one year for the military expenditures of both formal and informal allies, the defense expenditures of rival countries, and government social expenditures to avoid simultaneity.

The total military expenditures by formal and informal allies of nation *i* are net of nation *i*'s military expenditures. Previous studies (i.e., Gonzalez and Mehay) have proved this to be the best technique.

A nation is considered to be a "significant" rival to country *i* if two conditions exist: (1) a territorial or political conflict exists between the two nations that may induce either nation to employ armed force against the other; and (2) the ability of a nation to resist an attack is not negligible. Condition (2) requires that a nation's armed forces not be simply a token force.

Similarly, a given nation is considered to be a "significant" ally to country *i* if two conditions hold: (1) the relationship between the two countries, formal or otherwise, is such that the nation can be relied upon to support *i* in an armed conflict with a third party; and (2) the nation's potential military contribution in support of *i* is not negligible. Memberships in formal alliances and bilateral defense treaties were used in part in designating nations as allies and rivals. However, alliances and treaties were ignored in those cases where evidence suggests that the signatories do not intend to abide by an agreement. An example of the latter is the 14 Nation Treaty among African nations.

The variable *ME* represents a nation's total military spending in year *t*. The variables *FA*, *IA*, and *RIV* are the total formal, informal, and rival military expenditures respectively of country *i* in year *t*.

A nation's gross national product (GNP) is often used as a measure of its national income. However, GNP is the product of per capita income and population. Therefore, to form a more explanatory model, the variables per capita income (*PCI*) and population (*POP*) are used as separate variables instead of combining them to form total GNP.

If national income is held constant, an obvious trade-off will exist between social and defense spending. Therefore, this study incorporates the amount of a country's social spending measured as the annual non-military central government spending. The variable social expenditures (*SE*) is calculated as the difference between a nation's central government expenditures and its military expenditures.

The tradeoff between defense and social spending should impart a negative sign to the SE variable. On the other hand, a positive sign for the social spending variable could provide some indication of the government's general ability to tax the electorate at a given income level.

Following the Gonzalez and Mehay study (1987), the nature of the constitutional regime could have an important effect on military spending, independent of the external military environment. This factor is controlled by including a dummy variable, *NONDEM*, which equals unity when a country is classified as either a totalitarian or authoritarian regime.

A second dummy variable, *CONSTR*, is also included to capture those nations whose military spending is constrained by treaty or constitution. This variable is set equal to unity for three nations--Finland, Japan, and Austria.

The empirical model for estimating a nation's military expenditure is converted to a log-linear (constant elasticity) form by taking the log of all the variables excluding the dummy variables. This was necessary in order to perform the required regressions.

The model is used to test the explanatory power of the independent variables against the dependent variable, military expenditures. A regression is performed over an eleven year period on seventy-five countries using a statistical procedure known as the cross-pooled regression method. Unlike a routine regression, all factors are regressed over an eleven year period for all countries resulting in one regression line. The advantage of this method over others, such as the time series regression, is that it increases the variation in the dependent and explanatory variables.

IV. DATA COLLECTION

A. SAMPLE SELECTION

The countries used in this study are chosen based upon the research conducted by Rodolfo Gonzalez and Stephen Mehay [Ref. 4:p. 30] in their article, "An Economic Model of the Supply of Military Output." These countries include North Atlantic Treaty Organization (NATO) members; WARSAW Treaty Organization (WTO) nations; and developed (superpowers) and less developed (Third World) countries. Additionally, a distinction is made between democratic and non-democratic nations. The underlying criteria for selecting and including these particular countries are the availability of data and the capability to detect the relationship of interdependence with other nations. This is encompassed in the bureaucratic concept argued by Gonzalez and Mehay.

Countries will participate in organizations for the purpose of obtaining a good that, without the collective benefit of their membership, they could not independently produce the same quantity or quality. Nations must and do expend the resources required to procure whatever they deem to be the requisite amount of defense, security preparation, and protection for pre-war confrontations and full-scale war engagements. It is the contention of this research that military spending is affected by the size of the country, its per capita wealth, and the defense expenditures of its allies and rivals. Olson and Zeckhauser focus on the workings of alliances, but their comments are still relevant to the discussion at hand. They write: "In an alliance, the amount a nation spends on defense will be affected by the amount its allies provide...the more defense

this nation's allies provide, the further the cost constraint decreases and the less it spends on defense...The amount of defense that this nation provides will in turn influence the defense output of its allies...." [Ref. 3:p. 268] Therefore, the nations that provide an ample spectrum of characteristic backgrounds and influences as just discussed, were chosen for this study.

B. DATA PRESENTATION

The Appendix lists the 75 countries and relevant cross-sectional data selected for this research. The data covers an eleven year period, 1974-1984. Although data were collected for 141 nations, missing data for some variables reduced the usable sample to 75. The cross-sectional data utilized for this research was taken from the annual World Military Expenditures & Arms Transfer manual 1986, published by the United States Arms Control and Disarmament Agency. All data are presented in constant 1983 dollars. Variables used in Appendix A include:

YR = calendar year
ME = total government military expenditures in million dollars
GE = total government expenditures in million dollars
POP = population in millions
PI = income per capita in dollars
BK = country-specific designations such as NATO
* = data not available

Table 1 lists the relevant countries used over the eleven year period, 1974-1984, with their formal allies (FA), informal allies (IA), and rivals (RV).

C. QUALIFICATIONS

The military expenditure data may be of uneven accuracy and completeness. This could be caused by the number of different sources used to obtain the data or due to

TABLE 1

LIST OF COUNTRIES (Allies & Rivals)

Number	Country Name	FA	IA	RV
1.	Argentina	NA	NA	13,71
2.	Australia	33,39,52,71,72	30,63	54
3.	Austria	NA	NA	NA
4.	Bangladesh	NA	25	43
5.	Belgium	NATO (5,12,17, 21,22,29,32,38, 41,49,55,67,71, 72,74)	NA	WTO (8,15, 19,24,48, 50,54)
6.	Bolivia	NA	NA	NA
7.	Brazil	NA	NA	NA
8.	Bulgaria	WTO	NA	NATO
9.	Burkina Faso	NA	NA	NA
10.	Burma	NA	NA	NA
11.	Cameroon	NA	NA	NA
12.	Canada	NATO	NA	WTO
13.	Chile	NA	NA	1,46
14.	Colombia	NA	NA	73
15.	Czechoslovakia	WTO	NA	NATO
16.	Central African Republic	NA	NA	NA
17.	Denmark	NATO	NA	WTO
18.	Ecuador	NA	NA	46
19.	East Germany	WTO	NA	NATO

Number	Country Name	FA	IA	RV
20.	Finland	NA	NA	54
21.	France	NATO	NA	WTO
22.	Greece	NATO (except 67)	NA	WTO,67
23.	Guyana	NA	NA	73
24.	Hungary	WTO	NA	NATO
25.	India	NA	54	43,76
26.	Indonesia	NA	2,30	77
27.	Ireland	NA	NA	NA
28.	Israel	NA	72	54,59,78,79
29.	Italy	NATO	NA	WTO
30.	Japan	NA	2,72	54
31.	Kenya	NA	53,71,72, 80	54,81
32.	Luxembourg	NATO	NA	WTO
33.	Malaysia	2,39,52,71	72	54,77
34.	Mali	NA	NA	NA
35.	Malta	NA	NA	NA
36.	Mexico	NA	72	NA
37.	Nepal	NA	NA	NA
38.	Netherlands	NATO	NA	WTO
39.	New Zealand	2,33,52,71,72	NA	54
40.	Nigeria	NA	NA	NA
41.	Norway	NATO	57	WTO

Number	Country Name	FA	IA	RV
42.	Oman	NA	70,82,83 84,85	79
43.	Pakistan	NA	72,76	25,54
44.	Papa New Guinea	NA	NA	NA
45.	Paraguay	NA	NA	NA
46.	Peru	NA	NA	13,18
47.	Philippines	NA	72	NA
48.	Poland	WTO	NA	NATO
49.	Portugal	NATO	NA	WTO
50.	Romania	WTO	NA	NATO
51.	Senegal	NA	21	86,87
52.	Singapore	2,33,39,71	NA	77
53.	Somalia	NA	31,72	81
54.	Soviet Union	WTO	77,88,89	NATO,2,28, 30,57,76
55.	Spain	NATO	NA	WTO
56.	Sri Lanka	NA	NA	NA
57.	Sweden	NA	41	54
58.	Switzerland	NA	NA	NA
59.	Syria	NA	54	28,72,90
60.	South Africa	NA	NA	91,92
61.	South Korea	NA	72	54,89
62.	Tanzania	NA	NA	NA

Number	Country Name	FA	IA	RV
63.	Thailand	NA	2,72	77
64.	Togo	NA	NA	NA
65.	Trinidad-Tobago	NA	NA	NA
66.	Tunisia	NA	21	93
67.	Turkey	NATO (except 22)	NA	WTO,22
68.	Uganda	NA	62	NA
69.	Uruguay	NA	NA	NA
70.	United Arab Emirates	NA	42,82,83, 84,85	79
71.	United Kingdom	NATO,2,33, 39,52	NA	WTO,77
72.	United States	NATO,2,39	30,28,43, 61,76	WTO,59,77, 88,89
73.	Venezuela	NA	NA	14,23
74.	West Germany	NATO	NA	WTO
75.	Yugoslavia	NA	NA	54

Note: The following countries were not in the sample but were used in computing allies/rivals:

76. China	77. Vietnam	78. Iraq	79. Iran
80. Sudan	81. Ethiopia	82. Bahrain	83. Kuwait
84. Qatar	85. Saudi Arabia	86. Guinea	87. Guinea-Bissau
88. Cuba	89. North Korea	90. Jordan	91. Mozambique
92. Zimbabwe	93. Libya		

the recent deemphasis of the collection of such data by the Agency for International Development, a major source of data in the past. For example, there are indications or reasons to believe that the military expenditures reported by some countries (i.e., Ecuador and Syria) consist mainly or entirely of recurring or operating expenditures and omit most capital expenditures, including arms purchases.

Particular problems arise in estimating the military expenditures of communist countries due to the exceptional scarcity and ambiguity of released information. Data on Soviet military expenditures are based on Central Intelligence Agency (CIA) estimates of what it would cost in the United States in dollars to develop, procure, staff and operate a military force similar to that of the Soviet Union. These estimates are the best available; in fact, there are no alternative estimates available that can inspire equal confidence.

Unlike Western countries where statistics on the National Budget, Gross National Product, Industrial Output, Trade, Balance of Payments, etc. are accurately reported, WARSAW Pact nations treat such accounts as state secrets. This is not to say that official statistics are not published, but too frequently they are stagnant values repeated from one year to the next. To gain a true perspective of the problems, successes or failures in the various categories, Western analysts have turned to examining available data and intelligence for use in estimating the actual values.

For WARSAW Pact countries other than the Soviet Union, the estimates of military expenditures are from the publication "East European Military Expenditures," published by the Research Project on National Income in East Central Europe. These military expenditures refer only to the officially announced state budget expenditures

on national defense. Therefore, these figures understate total military expenditures in view of defense outlays by non-defense agencies of the central government, local governments, and economic enterprises. Possible subsidization of military procurement may also cause understatement. However, since the bias is consistent among the WARSAW pact countries, the effect on the statistical regression is not significant.

V. EMPIRICAL ANALYSIS

A. THEORETICAL HYPOTHESIS

This chapter addresses the central research question: Is there an inverse relationship between a country's military expenditure and that of its allies? The hypotheses tested are:

H_0: There is no inverse relationship between a country's military expenditure and that of *its formal allies*. *Mathematically*, this is expressed as $b_4 \geq 0$.

H_1: There is an inverse relationship between a country's military expenditure and that of its formal allies. Mathematically, this is expressed as $b_4 < 0$ (i.e., the regression coefficient is significantly different from zero and is negative).

H_0: There is no inverse relationship between a country's military expenditure and that of its informal allies. Mathematically, this is expressed as $b_5 \geq 0$.

H_1: There is an inverse relationship between a country's military expenditure and that of its formal allies. Mathematically, this is expressed as $b_5 < 0$ (i.e., the regression coefficient is significantly different from zero and is negative).

In the alternative hypotheses (H_1), both b_4 and b_5 are stated as less than zero. This implies that their values are negative. Given these are negative and significant, and taking into account the other variables in the model, the decision maker could postulate that an inverse relationship does exist.

The values b_4 and b_5 in the above expressions refer to the coefficients of the variables Formal Allies and Informal Allies in the basic model. The loglinear form of the basic model is expressed as follows:

$$\log ME_{it} = b_0 + b_1\log(POP_{it}) + b_2\log(PCI_{it}) + b_3\log(SE_{t-1}) + b_4\log(FA_{t-1}) + b_5\log(IA_{t-1}) + b_6\log(RIV_{t-1})$$

To fully support the "free rider" theory of Olson and Zeckhauser (1966), we expect the coefficients b_4 and b_5 to be negative and significant. In addition, b_4 should be more negative than b_5.

The level of significance is very important in any statistical analysis. The analyst must first determine how certain he or she wants to be in accepting or rejecting the null hypothesis (H_0). In other words, the decision maker establishes the risk level he or she is willing to tolerate in terms of rejecting a true null hypothesis. If H_0 is rejected when in fact it is true, a Type I error is committed. The probability of making a Type I error is given by a, also called the level of significance. That is,

P(Type I error) = a.

The larger the a, the more likely it is that H_0 will be rejected falsely. The analyst determines the size of a. For example, if he wants to be 99% sure of his result, an a = .01 is selected; if he wants to be 95% sure, an a = .05 is selected. The a value should always be set prior to collection of the data. For all the tests in this study, an a = .05 is used.

B. THE STATISTICAL REGRESSION

Routine computer regressions were run on the full sample of seventy-five countries and on six individual subsamples over the eleven year period, 1974-1984.

The full sample was further divided into six subsamples over the same period to determine the impact that the six independent variables had on these smaller groupings of nations.

In order to establish these smaller groupings of countries, all seventy-five countries were given politico-economic labels such as LDC (less-developed country), WTO (Warsaw Treaty Organization member), Western nations (advanced market economies) or NATO (North Atlantic Treaty Organization member). The final six subsample groupings are based on these title designations and include the following: (1) NATO; (2) Western; (3) WTO; (4) LDC; (5) WTO & LDC; (6) Western & LDC.

The following countries are included in the various subsamples for this study:

NATO: United States, Netherlands, Denmark, Luxembourg, West Germany, Norway, United Kingdom, Portugal, Spain, France, Italy, Greece, Turkey, Canada, Belgium.

Western: NATO countries plus Australia, Austria, Finland, Ireland, Japan, New Zealand, Sweden, Switzerland.

WTO: Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania, Soviet Union.

LDC: Argentina, Bangladesh, Bolivia, Brazil, Burkina Faso, Burma, Cameroon, Central African Republic, Chile, Colombia, Ecuador, Guyana, India, Indonesia, Israel, Kenya, Malaysia, Mali, Malta, Mexico, Nepal, Nigeria, Oman, Pakistan, Papua New Guinea, Paraguay, Peru, Philippines, Senegal, Singapore, Somalia, South Africa, South Korea, Sri Lanka, Syria, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Uganda, United Arab Emirates, Uruguay, Venezuela, Yugoslavia.

C. EMPIRICAL RESULTS

For all of the regressions, the dependent variable is the log military expenditures of the countries included in the particular sample. The independent variables are logarithms of population, per capita income, social expenditures, military expenditures

of formal allies, military expenditures of informal allies, rival military expenditures, constrained (present in only some samples), and nondemocratic (present in only some samples).

In each regression a group of statistics is generated to help determine the suitability of the model and guide the researcher in his acceptance or rejection of the hypothesis. The following is a brief description of each:

r^2 - the coefficient of determination. This measures the proportion of variation in the dependent variable that is explained by the variation in the independent variables in the regression model.

Adj r^2 - This is an adjusted value to reflect both the number of predictor or explanatory variables in the model and the sample size.

Parameter Estimate - gives an estimate for the value of the coefficients.

Standard Error - measures how much the parameter estimates would vary from one collection of data to the next. Standard errors can be used to construct confidence intervals about the parameter estimates.

T for H0 - gives the t-value for testing the null hypothesis that the parameter equals zero. These t-values are equal to the parameter estimates divided by their standard errors. They are used to test if the parameter estimates differ significantly from zero. As a general rule, if the t-value is greater than $\pm$ 1.96, the coefficient can be accepted as significant at the .05 level.

Prob > [T] - gives the "p-value" which is the probability of observing a t-value more extreme than the t-value obtained from the regression. The p-value is extremely important because it is the "observed level of significance," the smallest level at which

H_0 can be rejected for a given set of data. The analyst need only compare these p-values with a to determine whether or not the given variable is a significant explanatory one. If the p-value is less than a, H_0 can be rejected.

F Value, Prob > F - gives the test statistic and p-value associated with a test of the hypothesis that at least one variable in the overall model explains a significant portion of the variation in the data. In other words, it allows the entire model to be tested for significance. As a general rule, if the F-statistic is greater than 5.0, the model can be accepted as statistically significant.

1. NATO subsample

Table 2 shows the results of the regression analysis of the NATO countries. The adjusted r^2 value indicates that 96.92 percent of the variation in the model is explained by the independent variables. Likewise, since "Prob>F" is less than the significance level of a = .05, one can conclude that the regression as a whole is significant.

The variable IA is negative and significant which supports the theory of Olson and Zeckhauser. The variable FA is also negative but not significant. Therefore, their theory can not be completely supported given the regression results.

2. WESTERN subsample

Table 3 shows the results of the regression analysis of the Western countries subsample. The adjusted r^2 value indicates that a high percentage of the variation in the model is explained by the independent variables. Likewise, since "Prob>F" is less than the significance level of a = .05, the regression as a whole appears to be significant.

TABLE 2

NATO ANALYSIS OF VARIANCE

DEP VARIABLE: LOGME LOG MILITARY EXPENDITURES

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	6	550.55640	91.75940003	855.727	0.0001
ERROR	157	16.83507233	0.10722976		
C TOTAL	163	567.39147			

ROOT MSE	0.3274596	R-SQUARE	0.9703
DEP MEAN	8.255137	ADJ R-SQ	0.9692
C.V.	3.966737		

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB>[T]
INTERCEP	1	-1.69892785	0.37650582	-4.512	0.0001
LOGFA	1	-0.001769204	0.003271349	-0.541	0.5894
LOGIA	1	-0.01620329	0.002599416	-6.233	0.0001
LOGRIV	1	0.003956906	0.003232395	1.224	0.2227
LOGSE	1	0.002651345	0.02105472	0.126	0.9000
LOGPI	1	0.71982181	0.03974944	18.109	0.0001
LOGPOP	1	1.18439844	0.01902552	62.253	0.0001

VARIABLE	DF	VARIABLE LABEL
INTERCEP	1	INTERCEPT
LOGFA	1	LOG FORMAL ALLIES MILITARY EXPENDITURES
LOGIA	1	LOG INFORMAL ALLIES MILITARY EXPENDITURES
LOGRIV	1	LOG RIVALS MILITARY EXPENDITURES
LOGSE	1	LOG SOCIAL EXPENDITURES
LOGPI	1	LOG PER CAPITA INCOME
LOGPOP	1	LOG POPULATION

TABLE 3

WESTERN ANALYSIS OF VARIANCE

DEP VARIABLE: LOGME LOG MILITARY EXPENDITURES

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	6	710.24063	118.37344	672.134	0.0001
ERROR	245	43.14840383	0.17611593		
C TOTAL	251	753.38904			

ROOT MSE	0.4196617	R-SQUARE	0.9427
DEP MEAN	7.872221	ADJ R-SQ	0.9413
C.V.	5.330919		

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB>[T]
INTERCEP	1	-1.02691921	0.43284052	-2.373	0.0184
LOGFA	1	-0.01558098	0.003012485	-5.172	0.0001
LOGIA	1	-0.01514734	0.002359414	-6.420	0.0001
LOGRIV	1	0.002189391	0.002865129	0.764	0.4455
LOGSE	1	0.01347973	0.02112294	0.638	0.5240
LOGPI	1	0.61561329	0.04507859	13.656	0.0001
LOGPOP	1	1.15316012	0.02038248	56.576	0.0001

VARIABLE	DF	VARIABLE LABEL
INTERCEP	1	INTERCEPT
LOGFA	1	LOG FORMAL ALLIES MILITARY EXPENDITURES
LOGIA	1	LOG INFORMAL ALLIES MILITARY EXPENDITURES
LOGRIV	1	LOG RIVALS MILITARY EXPENDITURES
LOGSE	1	LOG SOCIAL EXPENDITURES
LOGPI	1	LOG PER CAPITA INCOME
LOGPOP	1	LOG POPULATION

The variables FA and IA are both negative and significant which fully supports the theory of Olson and Zeckhauser. Additionally, the variable FA is more negative than the variable IA and this was expected since the "free rider" effect is hypothesized to be stronger in a formal alliance.

3. WTO subsample

Table 4 shows the results of the regression analysis of the Warsaw Treaty Organization. The adjusted r^2 value of .9980 is extremely high and indicates that almost one hundred percent of the variation in the model is explained by the independent variables. Likewise, since "Prob>F" is less than the significance level of a = .05, the regression as a whole is significant.

The variables FA and IA are both negative and significant which fully supports the theory of Olson and Zeckhauser. However, the variable IA is more negative than the variable FA and this tends to contradict their theory.

The variable RIV is negative and significant which suggests that an inverse relationship exists between a communist country's military expenditures and the military expenditures of its rivals.

4. LDC subsample

Table 5 shows the results of the regression analysis of the Less Developed Countries subsample. The adjusted r^2 value is the lowest of all the subsamples, yet it indicates that 79.6 percent of the variation in the model is explained by the independent variables. Likewise, since "Prob>F" is less than the significance level of a = .05, the regression as a whole appears to be significant.

TABLE 4

WTO ANALYSIS OF VARIANCE

DEP VARIABLE: LOGME LOG MILITARY EXPENDITURES

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	6	137.68101	22.94683494	6187.873	0.0001
ERROR	68	0.25216819	0.003708356		
C TOTAL	74	137.93318			

ROOT MSE	0.06089627	R-SQUARE	0.9982
DEP MEAN	9.233937	ADJ R-SQ	0.9980
C.V.	0.6594833		

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB>[T]
INTERCEP	1	-3.04200226	0.70793302	-4.297	0.0001
LOGFA	1	-0.01525541	0.002073548	-7.357	0.0001
LOGIA	1	-0.04444542	0.002335416	-19.031	0.0001
LOGRIV	1	-0.02357944	0.002794211	-8.439	0.0001
LOGSE	1	0.007071116	0.01229130	0.575	0.5670
LOGPI	1	0.68330476	0.08484870	8.053	0.0001
LOGPOP	1	1.74083769	0.02327208	74.804	0.0001

VARIABLE	DF	VARIABLE LABEL
INTERCEP	1	INTERCEPT
LOGFA	1	LOG FORMAL ALLIES MILITARY EXPENDITURES
LOGIA	1	LOG INFORMAL ALLIES MILITARY EXPENDITURES
LOGRIV	1	LOG RIVALS MILITARY EXPENDITURES
LOGSE	1	LOG SOCIAL EXPENDITURES
LOGPI	1	LOG PER CAPITA INCOME
LOGPOP	1	LOG POPULATION

Neither variable FA nor IA are negative. There is no evidence of an inverse relationship, therefore, the null hypothesis cannot be rejected.

There is no evidence of an inverse relationship between the variables SE and ME. However, the variable SE is significantly positive and possibly indicates that in general, for LDC nations, their defense spending increases with an increase in social spending.

Another observation is that the variable NONDEM is positive and significant. This may suggest that a totalitarian or authoritarian regime has a positive effect on the military expenditures of non-democratic LDC nations. It is easier for non-democratic regimes to spend more on defense. These results are consistent with the Gonzalez and Mehay research.

5. WTO & LDC subsample

Table 6 shows the results of the regression analysis of the WTO/LDC subsample. The adjusted r^2 value increases with the addition of WTO countries to the LDC subsample. At .8683, it indicates that a higher percentage of the variation in the model is explained by the independent variables. Likewise, since "Prob>F" is less than a, the regression as a whole appears to be significant.

Neither variable FA nor IA are negative. There is no evidence of an inverse relationship, therefore, the null hypothesis cannot be rejected and the subsample does not support the theory of Olson and Zeckhauser. The variable IA is significantly positive and may suggest that there is a positive relationship between a country's defense spending and the defense spending of its allies which is consistent with the Sandler argument.

TABLE 5

LDC ANALYSIS OF VARIANCE

DEP VARIABLE: LOGME LOG MILITARY EXPENDITURES

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	7	1281.41969	183.05996	271.396	0.0001
ERROR	478	322.41748	0.67451356		
C TOTAL	485	1603.83717			

ROOT MSE	0.8212877	R-SQUARE	0.7990
DEP MEAN	5.673016	ADJ R-SQ	0.7960
C.V.	14.47709		

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB>[T]
INTERCEP	1	-5.01962139	0.36038240	-13.929	0.0001
LOGFA	1	0.002845855	0.004144597	0.687	0.4926
LOGIA	1	0.005661896	0.003459463	1.637	0.1024
LOGRIV	1	-0.000733747	0.003907063	-0.188	0.8511
LOGSE	1	0.06693371	0.02597946	2.576	0.0103
LOGPI	1	1.13985850	0.03861522	29.518	0.0001
LOGPOP	1	0.98781017	0.02927152	33.746	0.0001
NONDEM	1	0.25512187	0.13398197	1.904	0.0575

VARIABLE	DF	VARIABLE LABEL
INTERCEP	1	INTERCEPT
LOGFA	1	LOG FORMAL ALLIES MILITARY EXPENDITURES
LOGIA	1	LOG INFORMAL ALLIES MILITARY EXPENDITURES
LOGRIV	1	LOG RIVALS MILITARY EXPENDITURES
LOGSE	1	LOG SOCIAL EXPENDITURES
LOGPI	1	LOG PER CAPITA INCOME
LOGPOP	1	LOG POPULATION
NONDEM	1	NON-DEMOCRATIC

TABLE 6

WTO AND LDC ANALYSIS OF VARIANCE

DEP VARIABLE: LOGME LOG MILITARY EXPENDITURES

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	7	2231.87132	318.83876	528.261	0.0001
ERROR	553	333.77039	0.60356309		
C TOTAL	560	2565.64171			

ROOT MSE	0.776893 2	R-SQUARE	0.8699
DEP MEAN	6.149075	ADJ R-SQ	0.8683
C.V.	12.63431		

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB>[T]
INTERCEP	1	-5.09160431	0.32557321	-15.639	0.0001
LOGFA	1	0.00270247 9	0.003470462	0.779	0.4365
LOGIA	1	0.00714983 5	0.002778105	2.574	0.0103
LOGRIV	1	-0.000030275	0.003197592	-0.009	0.9924
LOGSE	1	0.04736550	0.02106279	2.249	0.0249
LOGPI	1	1.16478339	0.03520271	33.088	0.0001
LOGPOP	1	1.02294579	0.02436056	41.992	0.0001
NONDEM	1	0.42099477	0.10231441	4.115	0.0001

VARIABLE	DF	VARIABLE LABEL
INTERCEP	1	INTERCEPT
LOGFA	1	LOG FORMAL ALLIES MILITARY EXPENDITURES
LOGIA	1	LOG INFORMAL ALLIES MILITARY EXPENDITURES
LOGRIV	1	LOG RIVALS MILITARY EXPENDITURES
LOGSE	1	LOG SOCIAL EXPENDITURES
LOGPI	1	LOG PER CAPITA INCOME
LOGPOP	1	LOG POPULATION
NONDEM	1	NON-DEMOCRATIC

In the combined subsample, there is no evidence of an inverse relationship between the variable SE and the variable ME. However, the variable SE remains significantly positive and may indicate that defense spending increases with an increase in social spending.

The dummy variable NONDEM also remains positive and significant leading to the conclusion that a totalitarian or authoritarian regime may have a positive effect on the military expenditures of non-democratic LDC/WTO nations.

Although not central to this study, the results of this subsample also show that a nation's military expenditures increase as its income and population increases.

6. WESTERN & LDC subsample

Table 7 shows the results of the regression analysis of the combined Western/LDC countries. The adjusted r^2 value increases with the addition of Western countries to the LDC subsample. Now, 87.77 percent of the variation in the model can be explained by the independent variables. As well, since "Prob>F" is less than a, the regression as a whole is significant.

The addition of Western countries to the LDC sample causes no change to the coefficients of the variables FA or IA. Therefore, the null hypothesis cannot be rejected.

The SE variable remains positive and significant which may indicate that the military expenditures of these nations increase as the social expenditures increase. Similarly, the dummy variable NONDEM remains positive and significant.

TABLE 7

WESTERN AND LDC ANALYSIS OF VARIANCE

DEP VARIABLE: LOGME LOG MILITARY EXPENDITURES

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	8	2777.64719	347.20590	662.249	0.0001
ERROR	729	382.20250	0.52428326		
C TOTAL	737	3159.84969			

ROOT MSE	0.7240741	R-SQUARE	0.8790
DEP MEAN	6.423964	ADJ R-SQ	0.8777
C.V.	11.27145		

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB>[T]
INTERCEP	1	-4.51679781	0.22152643	-20.389	0.0001
LOGFA	1	0.003769554	0.003020645	1.248	0.2125
LOGIA	1	0.000851205	0.002378724	0.358	0.7206
LOGRIV	1	-0.001269960	0.002786616	-0.456	0.6487
LOGSE	1	0.04448357	0.01877921	2.369	0.0181
LOGPI	1	1.06494446	0.02090740	50.936	0.0001
LOGPOP	1	1.03402256	0.02018309	51.232	0.0001
NONDEM	1	0.45702306	0.10576054	4.321	0.0001
CONSTR	1	-1.13308411	0.14408636	-7.864	0.0001

VARIABLE	DF	VARIABLE LABEL
INTERCEP	1	INTERCEPT
LOGFA	1	LOG FORMAL ALLIES MILITARY EXPENDITURES
LOGIA	1	LOG INFORMAL ALLIES MILITARY EXPENDITURES
LOGRIV	1	LOG RIVALS MILITARY EXPENDITURES
LOGSE	1	LOG SOCIAL EXPENDITURES
LOGPI	1	LOG PER CAPITA INCOME
LOGPOP	1	LOG POPULATION
NONDEM	1	NON-DEMOCRATIC
CONSTR	1	CONSTRAINED

The dummy variable CONSTR is negative and significant. This indicates that for those countries constrained by treaty or constitution, their military expenditures are limited. This is consistent with the prior research of Gonzalez and Mehay.

7. FULL sample

Table 8 shows the results of the regression analysis for the Full sample of seventy-five countries. The adjusted r^2 value is high and "Prob>F" is less than *a* indicating that the regression as a whole is significant.

Both FA and IA variables are positive. As a result, the null hypothesis cannot be rejected and the theory of Olson and Zeckhauser is not supported.

The variable SE is significantly positive and may indicate that as a nation's social spending increases, its military expenditures also rise.

As expected, the dummy variable NONDEM is positive and significant and the dummy variable CONSTR is negative and significant. Both are consistent with the Gonzalez and Mehay research.

D. MULTICOLLINEARITY

In multiple regression analysis, the regression coefficients often become less reliable as the degree of correlation between the independent variables increases. If there is a high level of correlation between them, a problem called "multicollinearity" exists [Ref. 9:p. 672].

Multicollinearity is essentially a sample phenomena in the sense that even if the independent variables are not linearly related in the population, they may be related in the particular sample of study. It may happen that in any given sample some or all

TABLE 8

FULL SAMPLE ANALYSIS OF VARIANCE

DEP VARIABLE: LOGME LOG MILITARY EXPENDITURES

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	8	3442.50095	430.31262	880.676	0.0001
ERROR	804	392.84748	0.48861627		
C TOTAL	812	3835.34843			

ROOT MSE	0.6990109	R-SQUARE	0.8976
DEP MEAN	6.683186	ADJ R-SQ	0.8966
C.V.	10.45925		

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB>[T]
INTERCEP	1	-4.53199003	0.20549388	-22.054	0.0001
LOGFA	1	0.003501692	0.002687869	1.303	0.1930
LOGIA	1	0.001863448	0.002062609	0.903	0.3666
LOGRIV	1	-0.001317279	0.002426025	-0.543	0.5873
LOGSE	1	0.03369359	0.01615709	2.085	0.0374
LOGPI	1	1.07283749	0.01986904	53.995	0.0001
LOGPOP	1	1.05650440	0.01792181	58.951	0.0001
NONDEM	1	0.63610342	0.07134800	8.916	0.0001
CONSTR	1	-1.11859859	0.13833895	-8.086	0.0001

VARIABLE	DF	VARIABLE LABEL
INTERCEP	1	INTERCEPT
LOGFA	1	LOG FORMAL ALLIES MILITARY EXPENDITURES
LOGIA	1	LOG INFORMAL ALLIES MILITARY EXPENDITURES
LOGRIV	1	LOG RIVALS MILITARY EXPENDITURES
LOGSE	1	LOG SOCIAL EXPENDITURES
LOGPI	1	LOG PER CAPITA INCOME
LOGPOP	1	LOG POPULATION
NONDEM	1	NON-DEMOCRATIC
CONSTR	1	CONSTRAINED

of the independent variables are so highly collinear that one cannot isolate their individual influence on the dependent variable.

Multicollinearity is a matter of degree and not of type. The meaningful distinction is not between its presence or absence, but between its various degrees. Therefore, the researcher measures the degree of multicollinearity in a particular sample.

Table 9 shows the results of the collinearity diagnostics test for the full sample of seventy-five countries. The eigenvalue and condition number give an overall indication of the degree of multicollinearity present. The "bottom line" condition number shows the cumulative effect of multicollinearity. As a general rule of thumb, a "bottom line" condition number greater than 30 means that multicollinearity could be a problem in the sample. When this number is large, the problem is said to be "ill-conditioned"; when this number is extremely large, the estimates may have a fair amount of numerical error [Ref. 9:p. 672].

As shown in Table 9, the test yields a condition number of only 21.7 which indicates that the sample has a relatively low degree of multicollinearity. This was expected because the multiple regression had very few of the indicators of multicollinearity, namely high standard errors, relatively small computed t-values, and relatively large Prob>[T] values.

E. SUMMARY

Table 10 summarizes the various regression results. Of the six subsamples, WTO and Western fully support the theory of Olson and Zeckhauser. In these subsamples, the coefficient of the variable FA was more negative than the coefficient

TABLE 9

COLLINEARITY DIAGNOSTICS

NUMBER	EIGENVALUE	CONDITION NUMBER	VAR PROP INTERCEP	VAR PROP LOGFA	VAR PROP LOGIA	VAR PROP LOGRIV	VAR PROP LOGSE
1	4.561723	1.000000	0.0007	0.0035	0.0098	0.0001	0.0013
2	1.554812	1.712875	0.0000	0.0661	0.0000	0.1493	0.0002
3	0.945646	2.196344	0.0000	0.0000	0.0503	0.0815	0.0000
4	0.772934	2.429368	0.0000	0.0756	0.4270	0.0070	0.0000
5	0.708613	2.537231	0.0003	0.0009	0.0046	0.0827	0.0009
6	0.236938	4.387799	0.0042	0.4159	0.3976	0.4336	0.0152
7	0.185740	4.955777	0.0021	0.1144	0.0455	0.1861	0.0022
8	0.023909	13.812743	0.0017	0.3172	0.0648	0.0000	0.5821
9	0.0096857	21.702010	0.9911	0.0064	0.0004	0.0597	0.3980

NUMBER	VAR PROP LOGFI	VAR PROP LOGPOP	VAR PROP NONDEM	VAR PROP CONSTR
1	0.0012	0.0083	0.0083	0.0021
2	0.0000	0.0003	0.0000	0.0965
3	0.0000	0.0001	0.3250	0.2800
4	0.0001	0.0024	0.0060	0.1531
5	0.0000	0.0129	0.5412	0.3020
6	0.0041	0.0379	0.0028	0.0654
7	0.0122	0.8126	0.0122	0.0002
8	0.4952	0.0892	0.0913	0.0386
9	0.4871	0.0362	0.0133	0.0621

of the variable IA. The NATO subsample partially supports their theory because both coefficients were negative. The results indicate the "free riding" pattern of some nations on the defense output of others. However, the "free rider" theory cannot be completely supported because all the subsamples and the full sample should have yielded similar results.

The theory of Olson and Zeckhauser postulates that there is an inverse relationship between the military expenditures of nations and their allies. According to the theory, this inverse relationship applies to formal and informal allies. However, as table 10 shows, there is inconclusive evidence for this hypothesis, particularly during the period 1974-1984.

The "joint product" model of Sandler may be supported in those cases where the coefficient of both variables, FA and IA, are positive. There are four samples/subsamples where this occurs: Full sample, LDC, WTO/LDC, and Western/LDC. However, only one of the coefficients (IA for WTO/LDC) is significant at an $\alpha = .05$. Therefore, the Sandler argument cannot be fully supported either.

Although not central to this study, the results show that there is no evidence of an inverse relationship between a nation's income and its military expenditures. Likewise, the results reveal no evidence of an inverse relationship between a nation's population and its military expenditures. In all the samples the coefficients of the Population and Income variables were positively significant and may suggest that as a nation's income and population increase, its military expenditures also increase.

The coefficient of the variable Social Expenditures was significantly positive in four samples: Full sample, LDC, WTO/LDC, and Western/LDC. These results may

TABLE 10

REGRESSION SUMMARY OF COEFFICIENT ESTIMATES

Variable	Full Sample	NATO	WTO	LDC
FA	0.0035	-0.0018	-0.0153ss	0.0028
	(0.003)	(0.003)	(0.002)	(0.004)
IA	0.0019	-0.0162ss	-0.0444ss	0.0057s
	(0.002)	(0.002)	(0.002)	(0.003)
RIV	-0.0013	0.0039	-0.0236ss	-0.0007
	(0.002)	(0.003)	(0.003)	(0.004)
SE	0.0337ss	0.0027	0.0071	0.0669ss
	(0.016)	(0.021)	(0.012)	(0.026)
PI	1.0728ss	0.7198ss	0.6833ss	1.1399ss
	(0.019)	(0.039)	(0.084)	(0.038)
POP	1.0565ss	1.1844ss	1.7408ss	0.9878ss
	(0.018)	(0.019)	(0.023)	(0.029)
NONDEM	0.6361ss	NA	NA	0.2551ss
	(0.071)			(0.133)
CONSTR	-1.1186ss	NA	NA	NA
	(0.138)			
ADJ R^2	.8966	.9692	.9980	.7960

s = significant at .10
ss = significant at .05
(standard errors in parentheses)

TABLE 10 cont.

Variable	Western	WTO + LDC	Western + LDC
FA	-0.0156ss	0.0027	0.0038
	(0.003)	(0.003)	(0.003)
IA	-0.0151ss	0.0071ss	0.0008
	(0.002)	(0.003)	(0.002)
RIV	0.0021	-0.00003	-0.0012
	(0.003)	(0.003)	(0.003)
SE	0.0135	0.0474ss	0.0444ss
	(0.021)	(0.021)	(0.018)
PI	0.6156ss	1.1647ss	1.0649ss
	(0.045)	(0.035)	(0.021)
POP	1.1532ss	1.0229ss	1.0340ss
	(0.020)	(0.024)	(0.020)
NONDEM	NA	0.4209ss	0.4570ss
		(0.102)	(0.106)
CONSTR	NA	NA	-1.1331ss
			(0.144)
ADJ R^2	.9413	.8683	.8777

s = significant at .10
ss = significant at .05
(standard errors in parentheses)

suggest that the less developed countries increase their social expenditures with an increase in military expenditures. This of course contradicts the trade-off argument *between social and defense spending.*

The coefficient of the Rival variable was negative in all the regressions except NATO and Western. Of particular note, it was significant in the WTO subsample. This would indicate that as the defense spending of a rival (NATO) increased, the communist countries spent less on defense or vice versa.

In all the samples where the NONDEM and CONSTR variables were applicable, their coefficients were significant. The NONDEM variable was consistently positive and the CONSTR variable was consistently negative. The significance of these two dummy variables must not be overlooked. They provide an indication that the type of political regime and whether a nation uses *conscription or volunteer armed service* affects its military expenditures.

Computer regressions were run on the full sample and six subsamples for different time periods between 1974 and 1984. The purpose of these regressions was to determine if other factors relating to time period, such as the "flexible response doctrine" of the early 1970's or the Reagan defense build-up initiatives of the early 1980's, played a major role in the relationship of military expenditures of nations. The *regression results were essentially the same as those for the entire eleven year time* period. Therefore, one can conclude that specific year or time period was not a significant factor affecting a country's defense spending in relation to the defense expenditures of its allies and rivals.

VI. CONCLUSION

A. FINDINGS

The Stockholm International Peace Research Institute describes the meaning of military expenditure in the following way:

> Military expenditure figures, presented in different ways, have a variety of uses, including the measurement of the economic burden of these expenditures and the assessment of the trend in a nation's military strength. Moreover, the international comparison of military expenditures influences opinions about how much should be spent in the future. And, in military alliances, the relative economic burden of these expenditures between member nations is a frequently discussed, and often contentious, issue...As a general rule aggregate military expenditure is considered to be made up of the following components: 1) pay and allowances of military personnel, 2) pay of civilian personnel, 3) operations and maintenance (O&M), 4) procurement, 5) research and development (R&D), and 6) construction. In addition, in many or most cases the following activities are also regarded as military expenditure: 7) pensions to retired military personnel, 8) military aid, 9) civil defense, 10) para-military forces, and 11) military aspects of activities that are acknowledged as having a joint civil/military function, for example, space or atomic energy. By and large it is the expenditure aggregate made up of items 1 to 11 that is evaluated internally and compared internationally. The main point to be borne in mind is that the economic impact of the military is more pervasive than an analysis of explicit military expenditure would suggest. [Ref. 10:p. 5]

Distinct from this vein of thought, this research has attempted to reveal "significant" factors that were likely to have an influence on the outcome of a nation's military spending. It is inherently implied that when a nation makes expenditures for its security it will have less to spend in other areas of budgeted government spending. The idea of opportunity cost underlies this premise.

According to The Stockholm Research Institute, opportunity cost is a concept in economics that "stems from the fundamental postulate that resources are scarce." A

corollary of scarcity is that the employment of resources in one activity has a "cost" in terms of the output these resources might have produced in some other activity. [Ref. 10:p. 9]

The Research Institute further states that confining the analysis to specified military expenditure omits some potentially important aspects of the opportunity cost of the military. Specifically, to the extent that governments (a) allocate expenditures other than those explicitly labeled as military or (b) intervene in the private sector or (c) disrupt the pattern of international trade with military considerations in mind, there will be an additional cost in the sense that, from an economic and social viewpoint, resources will be misallocated both nationally and internationally. The Institute's approach to estimating opportunity cost is to take each major category of military expenditure and ask the following question: "Assuming a transfer of these military resources to civilian uses, is there any reason to suppose that the value of civilian output would be substantially different from the actual sum of (military) expenditure in these areas." [Ref. 10:p. 9]

There has been much research in the area of military expenditure patterns of alliances. According to Olson and Zeckhauser [Ref. 3:p. 268]:

> When a nation decides how large a military force to provide in an alliance, it must consider the value it places upon collective defense and the other, nondefense, goods that must be sacrificed to obtain additional military forces...In an alliance, the amount a nation spends on defense will be affected by the amount its allies provide.

The theme presented here is the traditional view and seems to hold true throughout most of the literature written on military alliances.

This study assumed that if members of an alliance increase or decrease their spending for security, it will affect their allies defense spending. Because defense is considered to be a "public good," an increase in the defense output by one member encourages another member to reduce its military output. The relationship among alliance members, however, is not proportional.

In contrast to the traditional view, Todd Sandler and his colleagues suggest that when the jointly produced outputs are complementary, allies could increase their defense expenditures in response to spill-ins. Commenting on the Olson and Zeckhauser model, Sandler [Ref. 8:p. 240] offers the following:

> They depicted NATO as sharing a pure public good in the form of deterrence, which relies on the credible threat of retaliation to forestall hostilities between opposing alliances. The punishment threat associated with deterrence is nonrival in consumption since additional allies can share this threat without diminishing the deterrence provided to existing allies...In particular, their model predicted that disproportionate burdens would be shouldered by the large, rich allies as the poorer allies rode free on the richer countries' defense contributions.

This study also assumed that because of the "public good" nature of defense smaller and less wealthy nations would take advantage of the alliance contributions of their larger and wealthier counter-parts.

This research focused on eight variables thought to have a significant influence on government decisions in the area of defense spending. These variables included: the size of a country's population (POP), income per capita (PI), government social expenditures (SE), military expenditures of formal allies (FA), military expenditures of informal allies (IA), military expenditures of rival countries (RIV), non-democratic nations (NONDEM), and countries constrained by treaty or constitution (CONSTR). The CONSTR variable applied only to Japan, Austria, and Finland.

In the case of the variable population, intuitively it should be assumed that the larger a nation, the more capital resources it may have and will probably spend on defense. This of course, assumes that the country considers the commodity of security as a "normal good." In other words, the more dollars a nation has available to spend, the more it will allot to obtain a greater quantity of this good. In their research, Gonzalez and Mehay conclude that there will be a proportional or more than proportional (depending on the presence of economies of size) increase between defense spending and corresponding changes in the size of a nation's population [Ref. 4:p. 19]. According to these two economists, there have been major deficiencies and inadequacies with prior models.

Although the coefficient of the variable population was positive and significant in all samples as expected, the results do not necessarily conclude that larger countries may be more or less efficient than smaller ones in their expenditures. The significant point is that the evidence may suggest that a positive relationship exists between military expenditures and the population of a country.

The coefficient of the variable per capita income was positive and significant in all samples. These results are consistent with prior research on military expenditures.

The coefficient of the variable social expenditures was positive in all samples and significant in the following four: Full sample, LDC, WTO/LDC, and Western/LDC. It was expected that the trade-off between defense and social spending would impart a negative sign to this variable. However, these results may indicate that there is a positive relationship between the social and military expenditures of many nations, particularly the less developed countries.

A possible explanation for this positive relationship would be the ability of the government to tax its people or control the majority of the nation's resources as in the case of a communist regime. This line of reasoning is supported by the results because the coefficient of the variable social expenditures was positive in all samples.

The coefficient of the Rival variable was negative and significant in the WTO subsample. This seems to indicate that as the defense spending of a rival increased, the WARSAW pact countries spent less on defense. Perhaps the contrary is true, as the communist countries spent more on defense, their rivals spent less. This last line of reasoning is plausible because if the trend in a rival country (i.e., US) over time is in the opposite direction of a WTO nation, this would impart a negative sign to the RIV variable. Such would be the case when NATO decreased its military expenditures during the aftermath of the Vietnam War in the 1970's and the Soviet Union increased its military spending.

The coefficients of the NONDEM and CONSTR dummy variables were significant in all applicable samples. The NONDEM variable was consistently positive and the CONSTR variable was consistently negative. These results were expected and are consistent with the Gonzalez and Mehay study.

The coefficients of the variables FA (military expenditures of formal allies) and IA (military expenditures of informal allies) were negative in three samples: NATO, WTO, and Western. This states clearly that the results from some of the samples lend support to the Olson and Zeckhauser view of an inverse relationship between the military expenditures of allies, but the results from other samples do not.

The results of this study are uniquely tied to country classifications. The effects of FA, IA, and RIV are based on the definition of what constitutes a formal ally, an informal ally or a rival. Different classifications could have yielded dissimilar results.

According to the theory, the inverse relationship applies to formal and informal allies alike. However, there is inconclusive evidence for this hypothesis, particularly during the period 1974-1984. It is possible that for a particular period in history (i.e., 1960's) alliance members behaved as the theory suggests; but today, twenty-three years after the Olson and Zeckhauser research, the world environment has changed.

B. RECOMMENDATIONS

This study is a first attempt into an uncharted area for thesis research. It should be repeated using different conceptualizations of country classifications to determine if the relationships found in this study are stable. Further research in this area is needed, but particular attention should be focused on the classification of the less-developed countries (LDC) to alleviate the possibility that the results may be incomplete and misleading. Additionally, only variables that have the fullest scope of sample data should be used in the model. The variable CONSTR did not encompass enough of a sampling to prove conclusively its influence and value in the model since it was composed of only three countries. Nevertheless, the results exposed some of the weaknesses in the Olson and Zeckhauser view of military alliances.

APPENDIX

COUNTRY DATA

YR	ME	GE	POP	PI	BK
Australia:					
1974	2599	24820	13.6	8880	WEST
1975	2672	30990	13.8	8897	WEST
1976	2731	34310	13.9	9002	WEST
1977	3040	35780	14.1	9142	WEST
1978	2981	35520	14.2	9098	WEST
1979	3052	35710	14.4	9392	WEST
1980	3593	39570	14.6	9716	WEST
1981	3818	40950	14.8	9859	WEST
1982	4028	42170	15.1	9897	WEST
1983	4308	45120	15.3	9651	WEST
1984	4502	48420	15.5	9990	WEST
Austria:					
1974	535	17470	7.6	7108	WEST
1975	597	18820	7.6	6990	WEST
1976	626	20250	7.6	7388	WEST
1977	648	20970	7.6	7689	WEST
1978	694	22880	7.6	7764	WEST
1979	734	23840	7.6	8172	WEST
1980	731	24630	7.6	8432	WEST
1981	726	25400	7.6	8420	WEST
1982	808	25910	7.6	8510	WEST
1983	890	27350	7.6	8830	WEST
1984	891	27160	7.6	8892	WEST
Belgium:					
1974	2003	28730	9.8	7467	NATO
1975	2175	31810	9.8	7285	NATO
1976	2326	34480	9.8	7685	NATO
1977	2391	36130	9.8	7759	NATO
1978	2560	38760	9.8	7999	NATO
1979	2622	40530	9.8	8142	NATO
1980	2712	42010	9.8	8286	NATO
1981	2801	45590	9.9	8155	NATO
1982	2750	46120	9.9	8242	NATO
1983	2672	46470	9.9	8242	NATO
1984	2580	46610	9.9	8372	NATO

YR	ME	GE	POP	PI	BK
Canada:					
1974	5108	59950	22.4	11680	NATO
1975	5039	65410	22.7	11630	NATO
1976	5288	64860	23.0	12130	NATO
1977	5667	65470	23.3	12220	NATO
1978	6018	69180	23.6	12530	NATO
1979	5630	68590	23.8	12770	NATO
1980	5727	71050	24.1	12800	NATO
1981	5922	76000	24.4	13060	NATO
1982	6532	80250	24.7	12320	NATO
1983	6563	83190	24.9	12600	NATO
1984	7350	89840	25.2	13100	NATO
Denmark:					
1974	1112	17080	5.0	9498	NATO
1975	1183	17390	5.1	9367	NATO
1976	1162	17220	5.1	9984	NATO
1977	1192	17680	5.1	10110	NATO
1978	1235	18370	5.1	10180	NATO
1979	1264	19690	5.1	10420	NATO
1980	1320	21560	5.1	10300	NATO
1981	1355	22760	5.1	10150	NATO
1982	1379	24120	5.1	10370	NATO
1983	1375	24900	5.1	10620	NATO
1984	1349	25440	5.1	10990	NATO
Finland:					
1974	479	10100	4.7	8172	WEST
1975	570	12030	4.7	8158	WEST
1976	511	12450	4.1	8144	WEST
1977	536	12840	4.2	8123	WEST
1978	558	12550	4.4	8290	WEST
1979	622	13320	4.7	8915	WEST
1980	719	13530	5.3	9392	WEST
1981	676	13720	4.9	9486	WEST
1982	740	14660	5.0	9695	WEST
1983	843	15530	5.4	9935	WEST
1984	764	15180	5.0	10150	WEST

YR	ME	GE	POP	PI	BK
France:					
1974	15950	151100	52.5	8145	NATO
1975	16420	163200	52.8	8111	NATO
1976	17090	171800	53.0	8508	NATO
1977	18110	176700	53.2	8736	NATO
1978	19090	187200	53.4	9027	NATO
1979	19620	197300	53.6	9303	NATO
1980	20210	201400	53.9	9364	NATO
1981	20990	217700	54.1	9353	NATO
1982	21280	235300	54.4	9452	NATO
1983	21650	235600	54.6	9442	NATO
1984	21600	241000	54.8	9510	NATO
West Germany:					
1974	20180	151100	62.0	9007	NATO
1975	19940	164600	61.8	8879	NATO
1976	20000	171500	61.5	9396	NATO
1977	19900	175700	61.4	9682	NATO
1978	20520	180800	61.3	10040	NATO
1979	20880	186400	61.3	10480	NATO
1980	21390	199600	61.6	10650	NATO
1981	22080	206300	61.7	10620	NATO
1982	21930	206900	61.6	10500	NATO
1983	22130	207500	61.4	10680	NATO
1984	22020	210000	61.2	11020	NATO
Greece:					
1974	1467	7843	9.0	3026	NATO
1975	1903	8538	9.0	3165	NATO
1976	2045	9784	9.2	3328	NATO
1977	2157	10570	9.3	3401	NATO
1978	2196	11270	9.4	3571	NATO
1979	2132	11490	9.5	3661	NATO
1980	1954	12330	9.6	3695	NATO
1981	2404	13910	9.7	3641	NATO
1982	2377	12770	9.8	3596	NATO
1983	2195	14680	9.8	3555	NATO
1984	2575	15340	9.9	3613	NATO

YR	ME	GE	POP	PI	BK
Ireland:					
1974	179	5880	3.1	4313	WEST
1975	249	6155	3.2	4303	WEST
1976	222	6392	3.2	4302	WEST
1977	236	6692	3.3	4510	WEST
1978	250	7419	3.3	4687	WEST
1979	253	8017	3.4	4701	WEST
1980	276	8834	3.4	4890	WEST
1981	270	9560	3.5	4933	WEST
1982	322	10300	3.5	4840	WEST
1983	312	10320	3.5	4781	WEST
1984	308	10390	3.6	4841	WEST
Italy:					
1974	7916	121200	55.2	5555	NATO
1975	7331	137500	55.6	5306	NATO
1976	7221	136800	55.8	5593	NATO
1977	7619	144100	56.1	5686	NATO
1978	7824	143900	56.2	5829	NATO
1979	8202	155700	56.4	6092	NATO
1980	8635	174900	56.5	6326	NATO
1981	8803	177600	56.5	6301	NATO
1982	9312	183500	56.6	6246	NATO
1983	9481	200800	56.8	6196	NATO
1984	9771	209000	57.0	6330	NATO
Japan:					
1974	6586	116700	110.2	7325	WEST
1975	7430	125200	111.6	7419	WEST
1976	7945	137000	112.8	7719	WEST
1977	8405	151700	113.9	8050	WEST
1978	9036	171000	114.9	8385	WEST
1979	9702	188000	115.9	8749	WEST
1980	9868	199000	116.8	9095	WEST
1981	10330	208600	117.6	9396	WEST
1982	10950	214400	118.4	9644	WEST
1983	11600	222100	119.3	9899	WEST
1984	12280	226700	120.0	10410	WEST

YR	ME	GE	POP	PI	BK
Luxembourg:					
1974	26	1100	0.4	10750	NATO
1975	31	1379	0.4	10610	NATO
1976	32	1449	0.4	10900	NATO
1977	33	1596	0.4	11260	NATO
1978	35	1593	0.4	11740	NATO
1979	36	1679	0.4	12420	NATO
1980	42	1767	0.4	12210	NATO
1981	43	1818	0.4	12240	NATO
1982	42	1829	0.4	12690	NATO
1983	41	1833	0.4	12500	NATO
1984	41	1773	0.4	13030	NATO
Netherlands:					
1974	3650	53470	13.5	8845	NATO
1975	3803	58600	13.7	8605	NATO
1976	3759	61340	13.8	9011	NATO
1977	4196	63810	13.9	9172	NATO
1978	4012	66830	13.9	9337	NATO
1979	4256	70500	14.0	9463	NATO
1980	4175	73520	14.1	9462	NATO
1981	4266	76150	14.2	9322	NATO
1982	4246	77750	14.3	9141	NATO
1983	4257	79910	14.4	9219	NATO
1984	4360	80450	14.4	9338	NATO
New Zealand:					
1974	340	7413	3.0	6888	WEST
1975	354	8716	3.1	6813	WEST
1976	331	7660	3.1	6803	WEST
1977	348	8099	3.1	6500	WEST
1978	346	8494	3.1	6514	WEST
1979	339	7977	3.1	6617	WEST
1980	396	8249	3.1	6740	WEST
1981	449	8972	3.1	6947	WEST
1982	469	9312	3.2	6833	WEST
1983	466	9975	3.2	7050	WEST
1984	454	10120	3.2	7298	WEST

YR	ME	GE	POP	PI	BK
Norway:					
1974	1210	15600	4.0	9859	NATO
1975	1332	16880	4.0	10230	NATO
1976	1372	19590	4.0	10720	NATO
1977	1417	20770	4.0	11030	NATO
1978	1537	21790	4.1	11380	NATO
1979	1549	22700	4.1	11850	NATO
1980	1513	22560	4.1	12380	NATO
1981	1525	21700	4.1	12460	NATO
1982	1602	22650	4.1	12420	NATO
1983	1699	22540	4.1	12890	NATO
1984	1623	22870	4.1	13400	NATO
Portugal:					
1974	1192	3011	9.1	1790	NATO
1975	813	3571	9.4	1635	NATO
1976	662	4300	9.6	1693	NATO
1977	614	6216	9.7	1774	NATO
1978	625	5018	9.7	1812	NATO
1979	661	4856	9.8	1913	NATO
1980	700	5404	9.8	1975	NATO
1981	707	5851	9.9	1951	NATO
1982	711	6657	9.9	1974	NATO
1983	693	6973	9.9	1970	NATO
1984	658	6979	10.0	1894	NATO
Spain:					
1974	3666	29510	35.2	3979	NATO
1975	3805	32200	35.6	3968	NATO
1976	3553	31530	36.0	4028	NATO
1977	2603	37460	36.4	4105	NATO
1978	2594	39970	36.9	4132	NATO
1979	2767	42850	37.2	4118	NATO
1980	2949	45330	37.5	4141	NATO
1981	3039	50460	37.8	4076	NATO
1982	3227	34720	38.1	4060	NATO
1983	3335	42040	38.3	4065	NATO
1984	3512	45900	38.6	4119	NATO

YR	ME	GE	POP	PI	BK
Sweden:					
1974	2779	27940	8.2	10060	WEST
1975	2731	28270	8.2	10240	WEST
1976	2693	31030	8.2	10310	WEST
1977	2559	33190	8.3	10040	WEST
1978	2676	35990	8.3	10130	WEST
1979	2780	38250	8.3	10550	WEST
1980	2736	39020	8.3	10650	WEST
1981	2779	41160	8.3	10510	WEST
1982	2863	41980	8.3	10530	WEST
1983	2888	44770	8.3	10760	WEST
1984	2831	44430	8.3	11050	WEST
Switzerland:					
1974	1890	16130	6.5	15330	WEST
1975	1775	16870	6.4	14250	WEST
1976	1991	18450	6.3	14270	WEST
1977	1905	18650	6.3	14730	WEST
1978	1863	18720	6.3	14710	WEST
1979	1980	19250	6.4	15080	WEST
1980	1994	19730	6.4	15680	WEST
1981	1983	19430	6.4	15930	WEST
1982	2034	19820	6.5	15610	WEST
1983	2055	20420	6.5	15730	WEST
1984	2130	21240	6.4	16220	WEST
Turkey:					
1974	1388	6943	39.5	904	NATO
1975	2278	8749	40.5	962	NATO
1976	2607	10060	41.5	1018	NATO
1977	2562	12330	42.4	1040	NATO
1978	2373	12390	43.3	1045	NATO
1979	1958	13300	44.2	1009	NATO
1980	1928	11610	45.1	977	NATO
1981	2291	11440	46.2	991	NATO
1982	2562	11870	47.3	1014	NATO
1983	2469	12390	48.4	1027	NATO
1984	2385	13550	49.5	1061	NATO

YR	ME	GE	POP	PI	BK
United Kingdom:					
1974	20590	164800	56.2	7366	NATO
1975	20150	177600	56.2	7262	NATO
1976	20860	175000	56.2	7523	NATO
1977	20320	165300	56.2	7612	NATO
1978	20490	172900	56.2	7888	NATO
1979	21100	178100	56.2	8019	NATO
1980	22010	178800	56.3	7799	NATO
1981	20770	178600	56.4	7684	NATO
1982	22040	186600	56.3	7806	NATO
1983	24170	193700	56.4	8088	NATO
1984	24570	193000	56.4	8270	NATO
United States:					
1974	163400	539100	213.9	13100	NATO
1975	157900	601700	216.0	12850	NATO
1976	148700	630800	218.0	13360	NATO
1977	155600	653300	220.2	13930	NATO
1978	155800	678200	222.6	14410	NATO
1979	161400	692700	225.1	14710	NATO
1980	174200	753000	227.7	14520	NATO
1981	190200	804600	230.0	14860	NATO
1982	205400	821700	232.3	14250	NATO
1983	217200	856000	234.5	14520	NATO
1984	229200	866900	236.7	15380	NATO
Israel:					
1974	5352	13660	3.3	6206	LDC
1975	6155	14810	3.4	6257	LDC
1976	6340	15920	3.4	6202	LDC
1977	5976	16490	3.5	6122	LDC
1978	5181	15570	3.6	6263	LDC
1979	6922	18950	3.7	6458	LDC
1980	7364	20000	3.8	6441	LDC
1981	6225	21770	3.8	6648	LDC
1982	5707	21400	3.9	6564	LDC
1983	6308	27050	4.0	6585	LDC
1984	6966	26650	4.0	6345	LDC

YR	ME	GE	POP	PI	BK
South Korea:					
1974	1723	6458	36.0	1102	LDC
1975	1985	7532	36.7	1158	LDC
1976	2728	8919	37.3	1300	LDC
1977	3083	10010	37.9	1442	LDC
1978	3608	11060	38.4	1558	LDC
1979	3309	12410	39.0	1636	LDC
1980	3714	12670	39.6	1529	LDC
1981	4044	14560	40.1	1606	LDC
1982	4238	15590	40.7	1668	LDC
1983	4390	15730	41.4	1838	LDC
1984	4437	16690	42.0	1963	LDC
Malta:					
1974	6	258	0.3	1656	LDC
1975	10	347	0.3	1978	LDC
1976	9	338	0.3	2263	LDC
1977	10	327	0.3	2498	LDC
1978	9	352	0.3	2681	LDC
1979	*	*	0.3	2867	LDC
1980	6	360	0.4	3005	LDC
1981	8	424	0.4	3134	LDC
1982	11	460	0.4	3266	LDC
1983	13	467	0.4	3202	LDC
1984	11	442	0.4	3279	LDC
Argentina:					
1974	1049	14440	25.6	2480	LDC
1975	1357	13570	26.1	2428	LDC
1976	1989	12410	26.5	2373	LDC
1977	2155	11460	26.9	2483	LDC
1978	1952	12630	27.4	2359	LDC
1979	2237	13560	27.9	2473	LDC
1980	2463	14560	28.3	2440	LDC
1981	2374	16060	28.8	2183	LDC
1982	3620	13980	29.3	2001	LDC
1983	2745	18360	29.7	2009	LDC
1984	2250	13050	30.2	2024	LDC

YR	ME	GE	POP	PI	BK
Bangladesh:					
1974	86	863	74.7	110	LDC
1975	69	647	76.2	11	LDC
1976	145	1359	77.9	12	LDC
1977	209	1701	80.4	10	LDC
1978	208	1606	82.9	14	LDC
1979	154	1726	85.5	16	LDC
1980	160	2072	88.1	14	LDC
1981	176	1893	90.6	18	LDC
1982	200	1918	93.3	15	LDC
1983	260	2011	95.9	16	LDC
1984	239	2479	98.6	18	LDC
Bolivia:					
1974	92	614	4.7	1172	LDC
1975	122	691	4.8	1226	LDC
1976	131	815	4.9	1268	LDC
1977	126	854	5.1	1277	LDC
1978	148	917	5.2	1281	LDC
1979	150	903	5.3	1232	LDC
1980	176	977	5.4	1174	LDC
1981	210	927	5.6	1136	LDC
1982	105	1418	5.7	953	LDC
1983	74	694	5.9	924	LDC
1984	116	2157	6.0	893	LDC
Brazil:					
1974	1814	27080	106.0	1375	LDC
1975	1726	31010	108.7	1408	LDC
1976	1996	34150	111.3	1506	LDC
1977	1692	42400	114.0	1552	LDC
1978	1556	45100	116.9	1588	LDC
1979	1419	44750	119.9	1643	LDC
1980	1441	51020	123.0	1708	LDC
1981	1424	55550	126.3	1623	LDC
1982	1917	59650	129.6	1579	LDC
1983	1726	61420	132.9	1479	LDC
1984	1719	60570	136.3	1505	LDC

YR	ME	GE	POP	PI	BK
Bulgaria:					
1974	3827	17240	8.7	5198	WTO
1975	3786	19200	8.7	5615	WTO
1976	3880	17660	8.8	5765	WTO
1977	3944	17590	8.8	5718	WTO
1978	3755	19670	8.8	5788	WTO
1979	3752	19940	8.8	6051	WTO
1980	3777	19480	8.9	5850	WTO
1981	3902	22720	8.9	6075	WTO
1982	4327	23380	8.9	6210	WTO
1983	4310	22430	8.9	6043	WTO
1984	4381	23080	9.0	6231	WTO
Burkina Faso (formerly Upper Volta):					
1974	10	89	5.5	148	LDC
1975	23	110	5.6	147	LDC
1976	26	129	5.7	158	LDC
1977	27	128	5.8	155	LDC
1978	30	128	5.9	163	LDC
1979	26	158	6.0	172	LDC
1980	26	149	6.1	174	LDC
1981	29	165	6.3	178	LDC
1982	30	169	6.4	174	LDC
1983	29	145	6.6	167	LDC
1984	29	168	6.7	162	LDC
Burma:					
1974	138	500	29.6	125	LDC
1975	140	492	30.2	128	LDC
1976	145	528	30.8	133	LDC
1977	159	607	31.4	137	LDC
1978	161	696	32.1	143	LDC
1979	173	708	32.7	147	LDC
1980	183	833	33.4	157	LDC
1981	199	894	34.1	163	LDC
1982	188	976	34.8	168	LDC
1983	190	954	35.5	171	LDC
1984	189	987	36.2	177	LDC

YR	ME	GE	POP	PI	BK
Cameroon:					
1974	47	458	7.3	428	LDC
1975	51	577	7.5	416	LDC
1976	59	643	7.7	425	LDC
1977	51	629	7.9	454	LDC
1978	63	734	8.1	494	LDC
1979	69	756	8.3	538	LDC
1980	75	824	8.6	598	LDC
1981	63	1247	8.8	660	LDC
1982	67	1311	9.0	681	LDC
1983	137	1674	9.2	705	LDC
1984	134	1691	9.5	727	LDC
Central African Republic:					
1974	14	159	2.0	331	LDC
1975	13	149	2.0	325	LDC
1976	13	121	2.1	331	LDC
1977	14	133	2.1	335	LDC
1978	14	134	2.2	335	LDC
1979	14	132	2.3	318	LDC
1980	14	124	2.3	298	LDC
1981	15	124	2.4	284	LDC
1982	15	147	2.4	283	LDC
1983	13	139	2.5	258	LDC
1984	*	*	2.6	273	LDC
Chile:					
1974	838	5895	10.0	1713	LDC
1975	700	5334	10.2	1432	LDC
1976	620	4812	10.4	1468	LDC
1977	680	5699	10.5	1598	LDC
1978	766	6069	10.7	1703	LDC
1979	713	5944	10.9	1810	LDC
1980	757	6268	11.0	1914	LDC
1981	828	6977	11.2	1964	LDC
1982	776	6192	11.4	1594	LDC
1983	759	6000	11.6	1563	LDC
1984	790	6659	11.8	1597	LDC

YR	ME	GE	POP	PI	BK
Colombia:					
1974	277	3305	23.6	1161	LDC
1975	338	3670	24.1	1158	LDC
1976	273	3261	24.6	1187	LDC
1977	223	3450	25.1	1221	LDC
1978	244	3879	25.5	1304	LDC
1979	341	4478	26.0	1355	LDC
1980	394	5119	26.5	1387	LDC
1981	380	5494	27.0	1383	LDC
1982	458	5746	27.6	1355	LDC
1983	505	5453	28.2	1343	LDC
1984	555	5569	28.7	1344	LDC
Czechoslovakia:					
1974	6286	32870	14.7	7110	WTO
1975	6449	35900	14.8	7280	WTO
1976	6239	37610	14.9	7365	WTO
1977	6306	99630	15.0	7679	WTO
1978	6370	36540	15.1	7689	WTO
1979	6267	36640	15.2	7768	WTO
1980	6518	37400	15.3	7904	WTO
1981	6731	40820	15.3	7944	WTO
1982	7202	39260	15.4	8024	WTO
1983	7271	40280	15.4	8070	WTO
1984	7388	40950	15.5	8298	WTO
Ecuador:					
1974	173	1055	6.8	1181	LDC
1975	214	1100	7.0	1260	LDC
1976	235	1254	7.2	1326	LDC
1977	236	1412	7.5	1378	LDC
1978	310	1256	7.7	1425	LDC
1979	269	1246	7.9	1437	LDC
1980	265	1766	8.1	1454	LDC
1981	274	2080	8.4	1464	LDC
1982	245	2028	8.6	1406	LDC
1983	200	1683	8.9	1327	LDC
1984	197	1737	9.1	1313	LDC

YR	ME	GE	POP	PI	BK
East Germany:					
1974	7789	55770	16.9	7636	WTO
1975	8136	57610	16.9	7974	WTO
1976	8277	60650	16.8	8177	WTO
1977	8367	63000	16.8	8492	WTO
1978	8494	66010	16.8	8577	WTO
1979	8643	69600	16.7	8894	WTO
1980	8791	73050	16.7	9074	WTO
1981	9197	76790	16.7	9399	WTO
1982	9720	81420	16.7	9321	WTO
1983	9966	84690	16.7	9420	WTO
1984	10330	89010	16.7	9769	WTO
Guyana:					
1974	14	198	0.8	688	LDC
1975	39	296	0.8	768	LDC
1976	47	389	0.8	768	LDC
1977	33	276	0.8	750	LDC
1978	21	249	0.8	743	LDC
1979	19	313	0.8	726	LDC
1980	22	386	0.8	728	LDC
1981	24	424	0.8	712	LDC
1982	27	*	0.8	628	LDC
1983	22	380	0.8	596	LDC
1984	23	*	0.8	632	LDC
Hungary:					
1974	3216	31480	10.5	6085	WTO
1975	3171	36100	10.5	6194	WTO
1976	2906	35020	10.6	6188	WTO
1977	2840	35980	10.6	6591	WTO
1978	2963	36040	10.7	6679	WTO
1979	2939	36600	10.7	6732	WTO
1980	3195	40040	10.7	6787	WTO
1981	3263	42370	10.7	6936	WTO
1982	3257	41120	10.7	7152	WTO
1983	3197	42100	10.7	7044	WTO
1984	3177	41790	10.7	7277	WTO

YR	ME	GE	POP	PI	BK
India:					
1974	3689	17530	607.7	200	LDC
1975	4338	22880	621.0	215	LDC
1976	4824	24120	634.4	214	LDC
1977	5346	25340	647.5	227	LDC
1978	5646	29360	660.7	237	LDC
1979	5235	29180	674.5	221	LDC
1980	5441	31620	689.0	232	LDC
1981	5966	32600	704.2	238	LDC
1982	6222	35660	719.8	242	LDC
1983	6776	37990	735.6	254	LDC
1984	6903	44240	751.6	258	LDC
Indonesia:					
1974	1331	8080	134.3	331	LDC
1975	1778	9932	137.5	339	LDC
1976	1757	11470	140.8	359	LDC
1977	1791	11120	144.3	378	LDC
1978	1913	12740	147.8	395	LDC
1979	1995	14580	151.4	405	LDC
1980	2089	16460	154.9	433	LDC
1981	2351	19380	158.5	463	LDC
1982	2373	17670	162.1	464	LDC
1983	2125	19130	165.8	467	LDC
1984	2138	17210	169.4	484	LDC
Kenya:					
1974	53	804	13.0	294	LDC
1975	64	955	13.5	287	LDC
1976	58	993	14.0	279	LDC
1977	103	928	14.6	294	LDC
1978	186	1286	15.2	302	LDC
1979	233	1444	15.8	305	LDC
1980	223	1458	16.4	309	LDC
1981	166	1657	17.1	315	LDC
1982	211	1707	17.8	302	LDC
1983	207	1537	18.6	299	LDC
1984	190	1512	19.4	287	LDC

YR	ME	GE	POP	PI	BK
Malaysia:					
1974	659	4144	12.0	1316	LDC
1975	752	4928	12.3	1314	LDC
1976	706	5125	12.6	1422	LDC
1977	927	6021	12.8	1495	LDC
1978	790	6276	13.1	1548	LDC
1979	853	5939	13.4	1651	LDC
1980	1059	8098	13.8	1762	LDC
1981	1556	11400	14.1	1848	LDC
1982	1616	13420	14.4	1882	LDC
1983	1443	12210	14.8	1910	LDC
1984	1154	11210	15.1	1990	LDC
Mali:					
1974	17	87	6.1	125	LDC
1975	20	95	6.2	138	LDC
1976	24	123	6.3	154	LDC
1977	27	145	6.5	162	LDC
1978	27	150	6.6	156	LDC
1979	27	157	6.8	169	LDC
1980	26	246	6.9	163	LDC
1981	25	248	7.1	154	LDC
1982	27	322	7.2	160	LDC
1983	27	340	7.4	149	LDC
1984	23	*	7.6	143	LDC
Mexico:					
1974	595	13930	59.7	1592	LDC
1975	771	17360	61.5	1634	LDC
1976	709	18070	63.2	1650	LDC
1977	695	18030	64.9	1664	LDC
1978	561	19710	66.6	1754	LDC
1979	614	22960	68.4	1859	LDC
1980	570	26600	70.1	1941	LDC
1981	757	33230	71.9	2025	LDC
1982	725	47500	73.8	1893	LDC
1983	726	38180	75.7	1759	LDC
1984	934	35370	77.7	1795	LDC

YR	ME	GE	POP	PI	BK
Nepal:					
1974	12	188	13.0	152	LDC
1975	12	182	13.3	151	LDC
1976	16	224	13.6	154	LDC
1977	20	281	13.9	155	LDC
1978	19	292	14.3	158	LDC
1979	20	301	14.6	158	LDC
1980	21	319	15.0	151	LDC
1981	23	353	15.4	159	LDC
1982	23	425	15.8	161	LDC
1983	28	494	16.2	152	LDC
1984	31	495	16.6	159	LDC
Nigeria:					
1974	2161	15830	74.8	984	LDC
1975	4016	25580	77.1	939	LDC
1976	3094	26680	79.5	1007	LDC
1977	3441	27900	81.9	1038	LDC
1978	2880	25590	84.5	956	LDC
1979	2385	27400	87.2	980	LDC
1980	2371	25390	90.0	965	LDC
1981	2271	16590	93.0	884	LDC
1982	1839	18980	95.9	827	LDC
1983	1644	16110	97.7	755	LDC
1984	1170	13040	99.9	697	LDC
Oman:					
1974	650	2028	0.7	3094	LDC
1975	1213	2355	0.8	3872	LDC
1976	1283	2652	0.8	4354	LDC
1977	1059	2315	0.8	4345	LDC
1978	1095	2161	0.9	3909	LDC
1979	1029	2172	0.9	4741	LDC
1980	1428	2877	1.0	6613	LDC
1981	1694	3497	1.0	7165	LDC
1982	1762	3711	1.1	6695	LDC
1983	1944	3961	1.1	6226	LDC
1984	2040	4375	1.2	6245	LDC

YR	ME	GE	POP	PI	BK
Pakistan:					
1974	1034	3659	72.9	251	LDC
1975	1153	4352	74.7	253	LDC
1976	1193	4568	76.5	260	LDC
1977	1083	4551	78.2	266	LDC
1978	1165	4762	80.1	284	LDC
1979	1189	5507	82.4	290	LDC
1980	1292	5469	85.2	306	LDC
1981	1403	5909	88.4	316	LDC
1982	1568	5770	91.5	318	LDC
1983	1934	6671	94.1	332	LDC
1984	1923	7126	96.6	338	LDC
Papua New Guinea:					
1974	*	*	*	*	LDC
1975	*	*	*	*	LDC
1976	31	676	2.7	768	LDC
1977	29	676	2.8	764	LDC
1978	33	765	2.8	813	LDC
1979	31	758	2.9	797	LDC
1980	35	811	3.0	741	LDC
1981	36	919	3.1	743	LDC
1982	34	869	3.1	714	LDC
1983	34	848	3.2	703	LDC
1984	39	833	3.3	704	LDC
Paraguay:					
1974	46	352	2.8	1263	LDC
1975	70	431	2.9	1308	LDC
1976	72	492	3.0	1353	LDC
1977	79	516	3.1	1487	LDC
1978	81	589	3.2	1576	LDC
1979	82	611	3.3	1708	LDC
1980	90	674	3.4	1825	LDC
1981	105	791	3.5	1928	LDC
1982	120	749	3.6	1852	LDC
1983	163	728	3.7	1736	LDC
1984	114	791	3.9	1753	LDC

YR	ME	GE	POP	PI	BK
Peru:					
1974	569	2808	14.8	1239	LDC
1975	757	3172	15.2	1246	LDC
1976	882	3352	15.6	1224	LDC
1977	1291	3282	16.0	1191	LDC
1978	969	3026	16.4	1076	LDC
1979	621	2903	16.8	1159	LDC
1980	1030	3811	17.3	1207	LDC
1981	924	3899	17.8	1227	LDC
1982	1015	3363	18.2	1199	LDC
1983	921	3069	18.7	1008	LDC
1984	1402	2962	19.2	1021	LDC
Philippines:					
1974	433	2614	43.3	515	LDC
1975	732	3761	44.4	532	LDC
1976	778	3900	45.6	555	LDC
1977	761	4004	46.8	576	LDC
1978	572	4218	48.0	594	LDC
1979	699	4150	49.3	619	LDC
1980	619	4570	50.5	634	LDC
1981	602	5219	51.7	639	LDC
1982	558	5267	53.0	636	LDC
1983	549	4776	54.3	628	LDC
1984	383	4031	55.5	572	LDC
Poland:					
1974	10740	50100	33.6	6027	WTO
1975	11030	61500	34.0	6265	WTO
1976	11450	61320	34.3	6368	WTO
1977	11710	66730	34.6	6471	WTO
1978	11440	71510	34.9	6588	WTO
1979	11480	78320	35.3	6463	WTO
1980	11570	83670	35.6	6245	WTO
1981	11500	86630	35.9	5947	WTO
1982	12920	60530	36.2	5798	WTO
1983	12240	52550	36.6	5986	WTO
1984	12990	58080	36.9	6159	WTO

YR	ME	GE	POP	PI	BK
Romania:					
1974	4848	35260	21.0	4006	WTO
1975	4951	38400	21.2	4151	WTO
1976	5111	41230	21.4	4562	WTO
1977	5040	44670	21.7	4591	WTO
1978	4970	45880	21.9	4797	WTO
1979	4841	51010	22.0	4967	WTO
1980	4591	42160	22.2	4854	WTO
1981	4563	36700	22.4	4905	WTO
1982	5140	28670	22.5	4974	WTO
1983	5189	24910	22.6	4926	WTO
1984	5172	26520	22.6	5149	WTO
Senegal:					
1974	27	387	4.9	370	LDC
1975	40	391	5.0	391	LDC
1976	60	435	5.1	423	LDC
1977	73	445	5.3	393	LDC
1978	76	389	5.4	354	LDC
1979	76	420	5.6	379	LDC
1980	83	500	5.8	354	LDC
1981	64	547	5.9	338	LDC
1982	65	665	6.1	378	LDC
1983	64	661	6.3	370	LDC
1984	61	732	6.5	339	LDC
Singapore:					
1974	389	1745	2.2	3768	LDC
1975	446	2200	2.3	4013	LDC
1976	523	2298	2.3	4191	LDC
1977	637	2500	2.3	4435	LDC
1978	606	2631	2.4	4826	LDC
1979	604	2857	2.4	5181	LDC
1980	704	3378	2.4	5458	LDC
1981	785	4451	2.4	5939	LDC
1982	809	4521	2.5	6285	LDC
1983	724	5232	2.5	6772	LDC
1984	982	4693	2.5	7355	LDC

YR	ME	GE	POP	PI	BK
Somalia:					
1974	47	223	4.0	253	LDC
1975	44	211	4.1	320	LDC
1976	43	213	4.2	309	LDC
1977	47	289	4.3	342	LDC
1978	101	413	4.7	341	LDC
1979	94	551	5.2	269	LDC
1980	79	426	6.1	218	LDC
1981	76	305	6.7	212	LDC
1982	85	423	7.0	215	LDC
1983	82	363	7.2	213	LDC
1984	103	373	7.4	213	LDC
South Africa:					
1974	1964	17310	24.9	2606	LDC
1975	2454	18710	25.5	2582	LDC
1976	3268	19780	26.1	2556	LDC
1977	3489	19750	26.7	2492	LDC
1978	3257	20300	27.4	2503	LDC
1979	3132	20410	28.0	2545	LDC
1980	3896	20200	28.7	2625	LDC
1981	3364	22030	29.4	2683	LDC
1982	2907	22960	30.2	2604	LDC
1983	3737	23900	30.9	2484	LDC
1984	3422	25980	31.7	2553	LDC
Soviet Union:					
1974	207300	335300	252.1	6352	WTO
1975	210000	298600	254.5	6419	WTO
1976	217300	325100	256.8	6598	WTO
1977	220500	342300	259.0	6738	WTO
1978	225300	360700	261.3	6931	WTO
1979	231000	392100	263.4	6906	WTO
1980	237200	428400	265.5	6968	WTO
1981	238500	459100	267.7	6993	WTO
1982	242700	505200	270.0	7088	WTO
1983	247000	508000	272.5	7214	WTO
1984	251300	528800	275.0	7266	WTO

YR	ME	GE	POP	PI	BK
Sri Lanka:					
1974	45	733	13.4	239	LDC
1975	54	876	13.7	250	LDC
1976	50	969	13.9	253	LDC
1977	42	866	14.1	263	LDC
1978	51	1589	14.4	273	LDC
1979	64	1590	14.6	285	LDC
1980	65	1884	14.9	296	LDC
1981	58	1580	15.2	303	LDC
1982	60	1691	15.4	310	LDC
1983	75	1726	15.7	320	LDC
1984	83	1754	16.0	333	LDC
Syria:					
1974	1271	3533	7.2	1439	LDC
1975	1987	5861	7.4	1709	LDC
1976	1978	6550	7.7	1779	LDC
1977	1895	6457	7.9	1685	LDC
1978	2093	5865	8.2	1775	LDC
1979	2387	5877	8.5	1798	LDC
1980	2802	7827	8.8	1884	LDC
1981	2587	6858	9.1	2042	LDC
1982	2855	8286	9.4	2017	LDC
1983	4044	9863	9.8	1935	LDC
1984	4114	9873	10.2	1812	LDC
Tanzania:					
1974	162	1345	15.3	343	LDC
1975	209	1759	15.8	344	LDC
1976	168	1373	16.3	346	LDC
1977	179	1469	16.9	337	LDC
1978	242	1645	17.4	331	LDC
1979	543	2101	18.0	331	LDC
1980	164	1787	18.5	335	LDC
1981	202	1698	19.1	320	LDC
1982	246	1961	19.7	313	LDC
1983	229	1731	20.4	301	LDC
1984	208	1626	21.0	300	LDC

YR	ME	GE	POP	PI	BK
Thailand:					
1974	591	2939	41.2	551	LDC
1975	627	3650	42.1	573	LDC
1976	777	4418	43.1	607	LDC
1977	900	4673	44.1	636	LDC
1978	1142	5324	45.0	679	LDC
1979	1349	5705	45.9	698	LDC
1980	1359	6489	46.9	722	LDC
1981	1352	6632	47.8	742	LDC
1982	1508	7815	48.8	754	LDC
1983	1519	7933	49.7	786	LDC
1984	1626	8206	50.6	814	LDC
Togo:					
1974	8	95	2.2	291	LDC
1975	11	173	2.3	289	LDC
1976	12	213	2.3	276	LDC
1977	42	309	2.4	286	LDC
1978	38	437	2.4	308	LDC
1979	18	335	2.5	285	LDC
1980	18	268	2.6	312	LDC
1981	19	264	2.7	286	LDC
1982	18	249	2.8	266	LDC
1983	16	240	2.8	240	LDC
1984	18	282	2.9	237	LDC
Trinidad and Tobago:					
1974	12	1135	1.0	4458	LDC
1975	13	1181	1.0	5110	LDC
1976	35	1795	1.0	5762	LDC
1977	34	1891	1.0	6076	LDC
1978	46	2303	1.1	6610	LDC
1979	59	2667	1.1	6519	LDC
1980	41	2794	1.1	7213	LDC
1981	50	3258	1.1	7225	LDC
1982	149	4054	1.1	7211	LDC
1983	227	5000	1.1	6607	LDC
1984	183	3048	1.2	5839	LDC

YR	ME	GE	POP	PI	BK
Tunisia:					
1974	68	1320	5.6	881	LDC
1975	84	1644	5.7	920	LDC
1976	81	1824	5.9	957	LDC
1977	86	2122	6.0	965	LDC
1978	95	2294	6.2	1004	LDC
1979	345	2550	6.3	1042	LDC
1980	282	2546	6.5	1096	LDC
1981	210	2674	6.7	1120	LDC
1982	312	3112	6.8	1092	LDC
1983	383	3407	6.9	1126	LDC
1984	265	3543	7.1	1164	LDC
Uganda:					
1974	247	1267	10.8	689	LDC
1975	192	1055	11.1	642	LDC
1976	187	1039	11.4	637	LDC
1977	134	638	11.8	625	LDC
1978	116	581	12.1	563	LDC
1979	61	320	12.5	467	LDC
1980	49	201	12.8	434	LDC
1981	52	173	13.1	447	LDC
1982	47	290	13.4	475	LDC
1983	51	355	13.8	483	LDC
1984	75	453	14.2	494	LDC
United Arab Emirates:					
1974	41	382	0.4	33050	LDC
1975	59	559	0.5	32110	LDC
1976	139	1115	0.6	33750	LDC
1977	810	2606	0.7	34940	LDC
1978	1172	2908	0.8	27040	LDC
1979	1580	3114	0.9	29800	LDC
1980	2087	5046	1.0	34030	LDC
1981	2340	6132	1.1	32290	LDC
1982	2071	6342	1.2	26650	LDC
1983	1973	5135	1.2	22220	LDC
1984	1868	4652	1.2	20300	LDC

YR	ME	GF	POP	PI	BK
Uruguay:					
1974	132	1122	2.8	1625	LDC
1975	133	1144	2.8	1709	LDC
1976	112	1248	2.9	1772	LDC
1977	121	1255	2.9	1797	LDC
1978	123	1274	2.9	1878	LDC
1979	137	1228	2.9	2001	LDC
1980	180	1366	2.9	2108	LDC
1981	244	1584	2.9	2153	LDC
1982	228	1727	2.9	1916	LDC
1983	170	1373	2.9	1739	LDC
1984	139	1280	2.9	1663	LDC
Venezuela:					
1974	987	20360	12.2	4558	LDC
1975	1172	20710	12.7	4781	LDC
1976	928	21270	13.1	4997	LDC
1977	1087	22330	13.6	5137	LDC
1978	1131	21060	14.1	5105	LDC
1979	1036	16320	14.6	4974	LDC
1980	903	18590	15.0	4694	LDC
1981	807	25150	15.5	4519	LDC
1982	1196	23470	15.9	4337	LDC
1983	995	19150	16.4	3984	LDC
1984	1031	18170	16.9	3822	LDC
Yugoslavia:					
1974	1733	8201	21.2	1675	LDC
1975	1891	8206	21.3	1671	LDC
1976	1804	8834	21.6	1740	LDC
1977	1859	4339	21.8	1873	LDC
1978	1845	4137	21.9	2013	LDC
1979	1975	4360	22.1	2098	LDC
1980	2013	4147	22.3	2108	LDC
1981	1942	3850	22.5	2108	LDC
1982	1785	3558	22.6	2116	LDC
1983	1665	3582	22.8	2052	LDC
1984	1731	3478	23.0	2071	LDC

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